MAR 21 1913

Engineering News

Issued Every Thursday
Hill Publishing Company

NEW YORK, MARCH 20, 1913

Price 15 cents a copy
To Canada 21. Foreign 26

Think Ahead To 1949

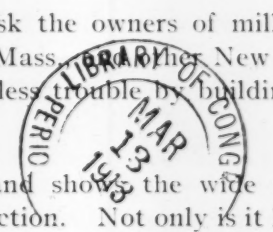
What wood structures now built or building will be in sound condition then?

The only way we have of judging is by the performance of various types of lumber in the past. When you examine wooden structures built 20, 30, 40, 50 or 60 years ago, you find that those built of

KYANIZED SPRUCE

are always in essentially as sound condition as when the lumber went into position,—even though the conditions are extremely favorable to decay. Bridges, Railroad Ties, Walks, Fences, Trestles, Basement Floors, etc., of Kyanized Spruce, built or put in place anywhere from one to two generations ago are now in 1913 sound and strong.

Does **Kyanized Spruce** pay? Ask the owners of mills in Lawrence, Holyoke, Brightwood and Lowell, Mass., and other New England points —who have saved money and endless trouble by building with a wood practically immune to decay.



Our catalog lists these builders and shows the wide applicability of **Kyanized Spruce** in wood construction. Not only is it lasting, but also light, cheap, strong, elastic and easily worked—making an admirable material for both outdoor and indoor use. The **B. M. Co. Kyanizing process** is absolutely permanent, does not affect the lightness, strength or handsome color of the spruce.

Drop us a line today for full information and ask for our interesting illustrated publication "Structural Wood and Its Preservation From Decay."

Be sure to specify "BERLIN MILLS CO." KYANIZED SPRUCE, every piece and stick of which bears the burnt mark "B. M. CO." This mark is a guarantee that the stock has been properly and thoroughly Kyanized.

Berlin Mills Company, Estab. 1852 Portland, Maine

New York Office: Woolworth Building

Corners, Junctions and Intersections Make No Troubles With Lackawanna Steel Sheet Piling

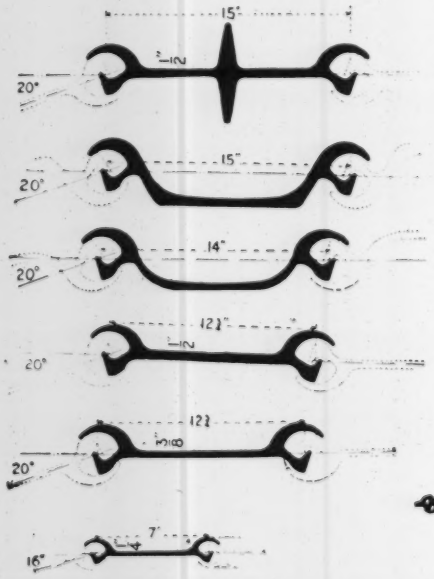
The meeting, crossing or deflecting of steel sheet piling walls at any angle is a simple matter where Lackawanna Steel Sheet Piling is used.

All ordinary junctures are provided for by the fabricated specials shown at the right, which consist of half sections combined with full or other half sections strengthened by structural angles and riveted, and made in sizes to fit all the Lackawanna types of sections as shown at the left. These fabricated units can be made so as to include angles other than 90 degrees, when specially required.

The flexibility of each interlocked piling joint, permitting an angular deflection of 16 deg. with the smallest and 20 deg. with all other Lackawanna sections, further makes practical the crossing or joining of walls at any angle and with very little deflection, if any, at the juncture.

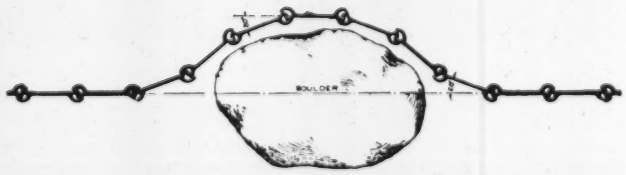
Lackawanna Steel Sheet Piling, in the matter of passing the piling line around an obstruction, is easily the most flexible on the market, yet this advantage is not secured at the expense of any other.

The interlocked joint strength, as has been proven by tests under United States Government supervision, is the highest obtainable with any practical form of steel sheet piling and the driving qualities have likewise been proven to excel.



When you buy Lackawanna Steel Sheet Piling you therefore buy the best from every standpoint,—adaptability, strength and driving economy. And you get free the advice of an engineering department equipped with experience accumulated from the world's most important steel sheet piling installations.

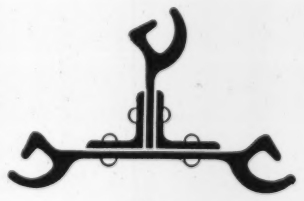
Tell us your piling requirements and ask for literature.



NO. 1
(STANDARD TEE)

NO. 2
(STANDARD CORNER)

NO. 3
(STANDARD CROSS)



NO. 4
(SPECIAL TEE)

NO. 5
(SPECIAL CORNER)

NO. 6
(SPECIAL CORNER)

LACKAWANNA STEEL COMPANY

General Sales Offices and Works: Lackawanna, N. Y.

NEW YORK BOSTON BUFFALO PHILADELPHIA CLEVELAND CINCINNATI CHICAGO DETROIT ST. LOUIS ATLANTA SAN FRANCISCO

Engineering News

CHARLES WHITING BAKER, *Editor*

Subscriptions payable in advance, $5.00 a year for 52 numbers, including postage in the United States, Mexico, Cuba, Porto Rico, Hawaii, or the Philippines, $7.00 in Canada.

Published Weekly By HILL PUBLISHING COMPANY
505 Pearl Street, New York, N. Y.

JOHN A. HILL, Pres. ROB'T MCKEAN, Sec'y.
Cable Address: "ENGNEWS"

To foreign countries, including postage, $9.00 or its equivalent, 38 shillings: 38 marks: or 45 francs. Notice to discontinue should be written to the New York Office in every instance. Advertising copy should reach New York Office by Thursday of week before date of issue. Entered at New York Postoffice as mail matter of the second class.

VOLUME 69 MARCH 20, 1913 NUMBER 12

CONTENTS

WITH PRINCIPAL ARTICLES SUMMARIZED

*Illustrated Article

*CROOKED RIVER BRIDGE, OREGON: *Page* 549

Description of a two-hinged steel arch bridge, 340-ft. span; Crooked River cañon crossing of the Oregon Trunk Ry.; details of foundation, steel superstructure, hinges, erection methods and devices, etc. 5000 w. 12 ill. Clement E. Chase. ENGINEERING NEWS, Mar. 20, 1913.

*LIQUID METER OF THE MEASURING TANK TYPE: *Page* 555

Description of a registering meter made by the Alberger Pump & Condenser Co. 200 w. 1 ill. ENGINEERING NEWS, Mar. 20, 1913.

*NOVEL TUNNEL WORK ON THE CLEVELAND SHORT LINE RY.: *Page* 556

Describes double-track concrete tunnels built by the Lake Shore & Michigan Southern Ry. around the south side of Cleveland, Ohio; tunnels built in open cut and backfilled; extremely heavy reinforced-concrete lining; sewers carried in crown by steel trusses embedded in concrete. 2000 w. 5 ill. ENGINEERING NEWS, Mar. 20, 1913.

*TEMPORARY HYPOCHLORITE PLANT FOR TREATING THE SEWAGE OF NORRISTOWN, PENN.: *Page* 558

Description of plant for treating sewage flowing into the Schuylkill River, which was used temporarily as a water supply for a part of Philadelphia. 1000 w. 3 ill. S. Cameron Corson. ENGINEERING NEWS, Mar. 20, 1913.

NEW ULTRA-VIOLET RAY LAMPS: *Page* 559

Describes new lamps developed in France, which possess an ultra-violet radiation 50 to 60 times more intense than a 110-volt lamp of 75 volts and 3.4 amp. 600 w. ENGINEERING NEWS, Mar. 20, 1913.

*OLD-TIME OVERSHOT WATERWHEEL IN CONNECTICUT: *Page* 559

Description of a water-power plant 75 years old. 300 w. 1 ill. ENGINEERING NEWS, Mar. 20, 1913.

*LARGE REINFORCED-CONCRETE GIRDER BRIDGE: *Page* 560

Description of girder bridge with 44-ft. spans; country highway service across Iowa River near Marshalltown, Iowa. 1000 w. 3 ill. Harry J. Rodgers. ENGINEERING NEWS, Mar. 20, 1913.

*SHIFTING THE COLUMN OF AN ELEVATED RAILWAY: *Page* 561

Describes method of moving column and reconstruction of bent of Chicago & Oak Park Elevated Ry., Chicago, Ill. 500 w. 1 ill. ENGINEERING NEWS, Mar. 20, 1913.

SAND-CEMENT AS USED BY THE U. S. RECLAMATION SERVICE: *Page* 562

Abstract of a discussion by C. H. Paul, Construction Engineer of the Arrowrock Dam, U. S. Reclamation Service, before American Society of Civil Engineers; supplementing paper before same society by J. B. Lippincott on "Tufa cement"; tests of sand-cement and portland cement; cost of manufacture, etc. 2500 w. ENGINEERING NEWS, Mar. 20, 1913.

NONCORROSIVE IRON ALLOY: *Page* 563

Descript on of metal known as "duriron," made by the Dayton Malleable Iron Co. 700 w. ENGINEERING NEWS, Mar. 20, 1913.

*REPORT OF THE ALASKA RAILROAD COMMISSION: *Page* 564

Abstract of report of commission appointed by President Taft in 1912 to examine railway routes in Alaska; resources of Alaska; present transportation routes. 5000 w. 1 ill. ENGINEERING NEWS, Mar. 20, 1913.

*WOOD PAVING WITH LUG BLOCKS: *Page* 567

Describes special form of creosoted wood block paving invented by H. G. Jennison. 200 w. 1 ill. ENGINEERING NEWS, Mar. 20, 1913.

FIELD AND OFFICE:

*Clearing Up Steel Wreckage at Low Cost 568
*Concrete Sewer-pipe Tests in Kansas City. E. S. Wallace 568
*Quick-acting Steam-operated Trip for Dredge Dippers; Panama Canal 569
*Some Short-cuts in Reinforced-concrete Beam Design; M. J. Lorente 570
*Two Common Faults in Detailing Windbracing. H. Arthur 572
Range-finder Stations for Forest Fires 573
*Fractional Wage Diagram 574
*Frog-angle Triangle for Plotting Turnouts. W. W. Gruber 575
Cost of Erecting a Steel Bridge 575
NOTES 576
*Diagram for Wheel and Truck Clearances of Cars. Willis Boothe 578
*Formulas for Radial Distances between Curves. George Paaswell 579

*TWO TESTS ON CAST-IN-PLACE CONCRETE PILES: *Page* 592

Describes tests made by author on groups of piles at Long Island City, N. Y., in soft water-bearing loam and sand. 800 w. 2 ill. Francis L. Pruyn. ENGINEERING NEWS, Mar. 20, 1913.

*IMPROVEMENT OF THE CUYAHOGA RIVER AT CLEVELAND, OHIO: *Page* 593

Abstract of a report of a commission appointed to study scheme for straightening the Cuyahoga River as an inner development of Cleveland harbor. 2000 w. 1 ill. ENGINEERING NEWS, Mar. 20, 1913.

EDITORIAL: *Page* 581
LETTERS: *Page* 585
ENGINEERING NEWS OF THE WEEK: *Page* 595
PERSONALS: *Page* 596
ENGINEERING SOCIETIES: *Page* 598
CONSTRUCTION NEWS: *Page* 43
CONTRACTS TO BE LET: *Page* 57
WANT ADVERTISEMENTS: *Page* 63
ADVERTISING INDEX: *Page* 112

CIRCULATION OF THIS NUMBER OF ENGINEERING NEWS 21,000

None sent free regularly, no returns from news companies, no back numbers

What The Buyer Needs To Know

Number Twelve

"Anybody who can write, can write an advertisement. But the question is whether it will sell anything or not," was the statement of one of the biggest general-magazine advertisers of the country the other day.

Is this a fact?

Is a set of rhymed words that looks like a poem when printed on a page, but that never stirs anyone to an iota of feeling, a poem? Is a brain which never thinks a brain? Is a salesman who nevers sells anything a salesman?

We don't think so; neither do we think a half-page or a page or a double page of words about something that is to sell, but which never induces anyone to buy it or investigate it, an advertisement.

An advertisement means at core a thing that makes somebody *turn to* something.

If the advertisement is worth its name, it will *turn* certain people who are interested in that class of goods *to* the particular representative of that class it refers to. It turns them because it makes them see in that product some certain characteristic that, they think, would constitute it their most profitable investment. And if the investigation verifies this impression, such "turnings-to" mean sales.

That is an advertisement.

And herewith another thing becomes apparent:

A real advertisement cannot be written about inferior goods.

When you see an advertisement, so called, that is all vacuous general statements, you can be sure of one of a brace of things:

Either the subject under discussion won't bear scrutiny.

Or the author of the copy didn't know how to write an advertisement.

You can't go into particulars about goods whose makers have spent most of their time in building up the glossed-over impression that their goods are as good or better than the next man's "because they are." It is the particulars behind the "because" that the latter-day buyer is wrapped up in.

Particulars sting down to those little differences, *and to the big differences which the little ones hide*, that appeal to the man who thinks before he acts, and who pays small attention to an advertisement that does not make him think. Such a man is quite apt to believe that "wide-as-the-sky" statements are the refuge of the lagger.

Of course they may not be.

Poor advertisements can be written about good products, and those same goods sell mightily, too. They may have no competition, or no competition at all in quality, or else the sales may be impelled by costlier ways of publicity for which the buyer foots the bill in the end.

All this gets us to our point:—

When the advertising writer puts together a convincing advertisement that turns you to investigate something in the Selling Section and then, quite likely, to buy that thing, he performs a service for you by getting you to as efficient, or the most efficient machine, appliance, whatever it be, that the market can give you—without the "exploration-worry" on your own part after a thing that is at once reliable and suited for the immediate purpose.

Engineering News advertisements are for you, and when you read them and act on them, *you serve yourself.*

Engineering News

VOLUME 69 MARCH 20, 1913 NUMBER 12

The Crooked River Bridge, Oregon

BY CLEMENT E. CHASE*

A notable example of the spandrel-braced two-hinged arch has just been erected on the Oregon Trunk Ry. (the new Hill line into central Oregon) at the crossing of Crooked River cañon, about 26 miles north of Bend, Ore. This is 130 miles south of Fallbridge, Wash., where the new line leaves the Spokane, Portland & Seattle Ry. and crosses the Columbia River on the Celilo bridge, recently completed. To reach the central portion of the state the road follows up the cañon of the Des Chutes River for 95 miles, with a gradient not exceeding 0.6%, and then climbs onto the central Oregon plateau in 20 miles of 1.3% grade, leaving the Des Chutes and working up Willow Creek Cañon. Just north of Madras, where the cañon widens out into a broad and fairly level plain, the line passes under the viaduct which carries the Des Chutes R.R. (the Harriman road which parallels the Oregon Trunk) over Willow Creek Cañon, 222 ft. above. From this point the remaining 46 miles to Bend, the present terminus, is over a great rolling plain, across which Crooked River zigzags its way in a very deep and very precipitous gorge in the basalt country-rock.

At the site of the bridge the cañon narrows down to about 350 ft. in width, with a steep and broken slope on the north side and a sheer cliff of 300 ft.—overhanging in many places—on the south. Both walls are basalt, with a markedly columnar fracture. The rim of the cañon is deeply cracked and seamed for some distance back from the edge, and the action of the weather yearly adds new boulders to the talus slopes below.

The site naturally adapted itself to an arch span, as the opening was comparatively narrow, the walls capable of taking unlimited thrust when excavated below the

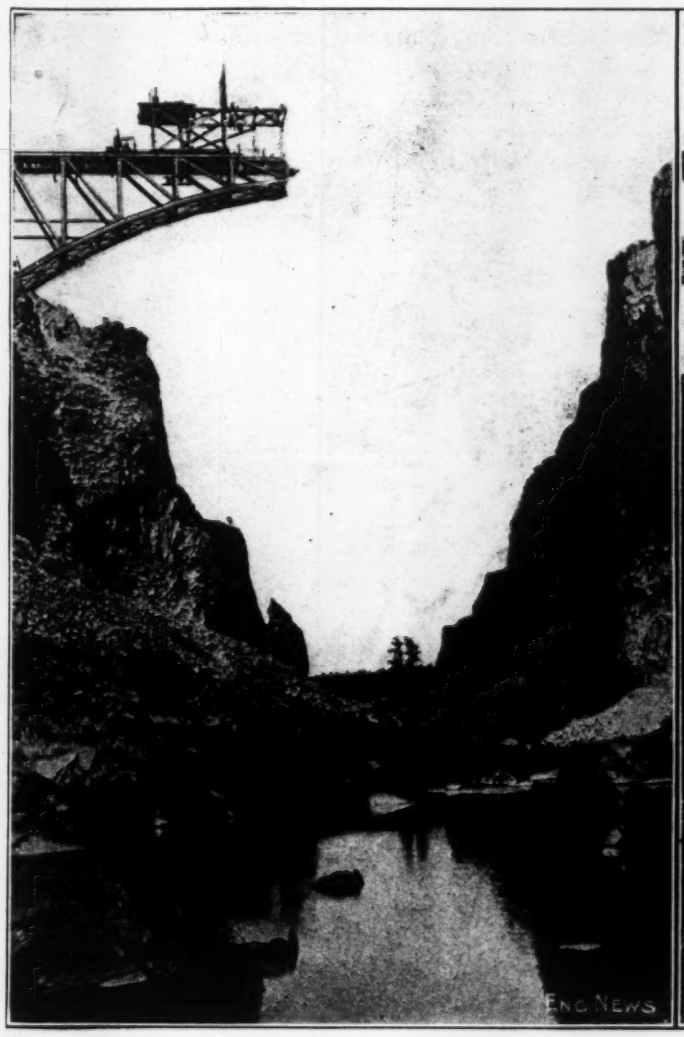


FIG. 1. FIVE PANELS OF NORTH HALF ERECTED

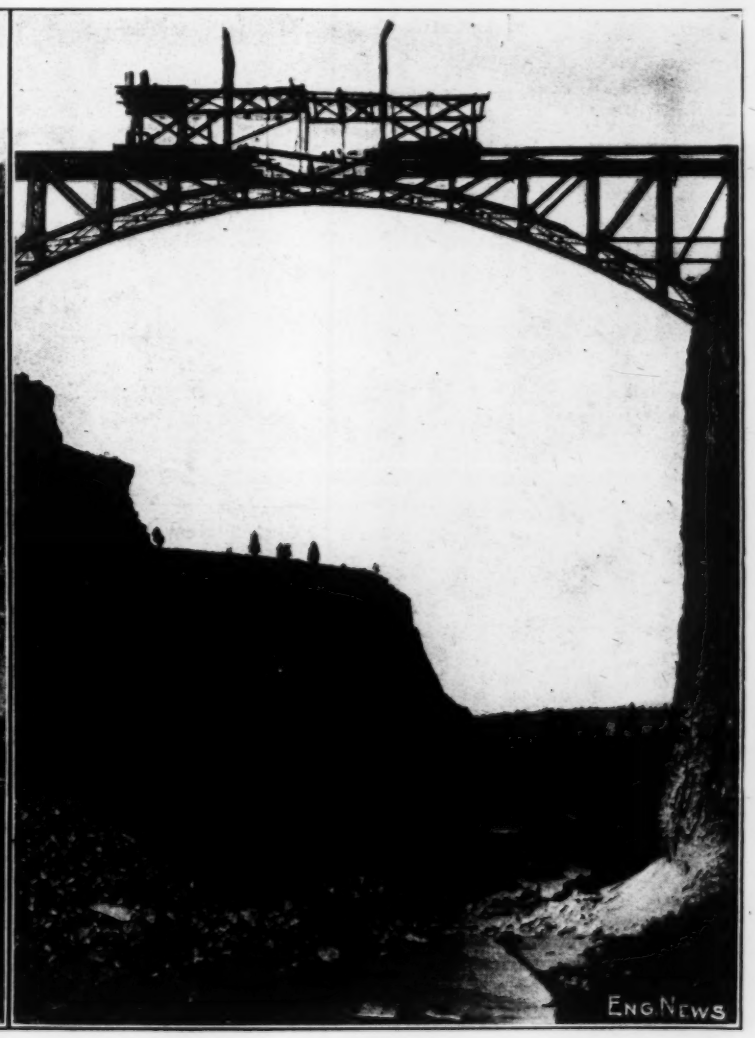


FIG. 2. SETTING CLOSING SECTION OF TOP CHORD, SEPT. 2, 1911

*510 Michigan Apartments, Toledo, Ohio.

cracked and weathered surface rock, and the depth so great that cantilever erection was necessary. The spandrel-braced arch lends itself very readily to the latter requirement. In this case it was particularly well adapted, as the first two sections of top chord were the only members whose section was affected by the erection stresses, and in no members were these stresses of different nature from those to be expected in service (since all the web and top-chord members experience reversal of stress under certain live-load and temperature conditions). A viaduct, besides requiring extremely high towers, would have been in danger of damage at any time from the rock slides which are continually occurring along the steep walls.

The uncertainty connected with the construction of the ordinary type of two-hinged arch from the difficulty of securing the proper division of dead-load compression between the top and bottom chords at the crown, was done away with by the feature in the design which caused the dead-load stresses in the structure to be those of a three-hinged arch, while the live-load and temperature

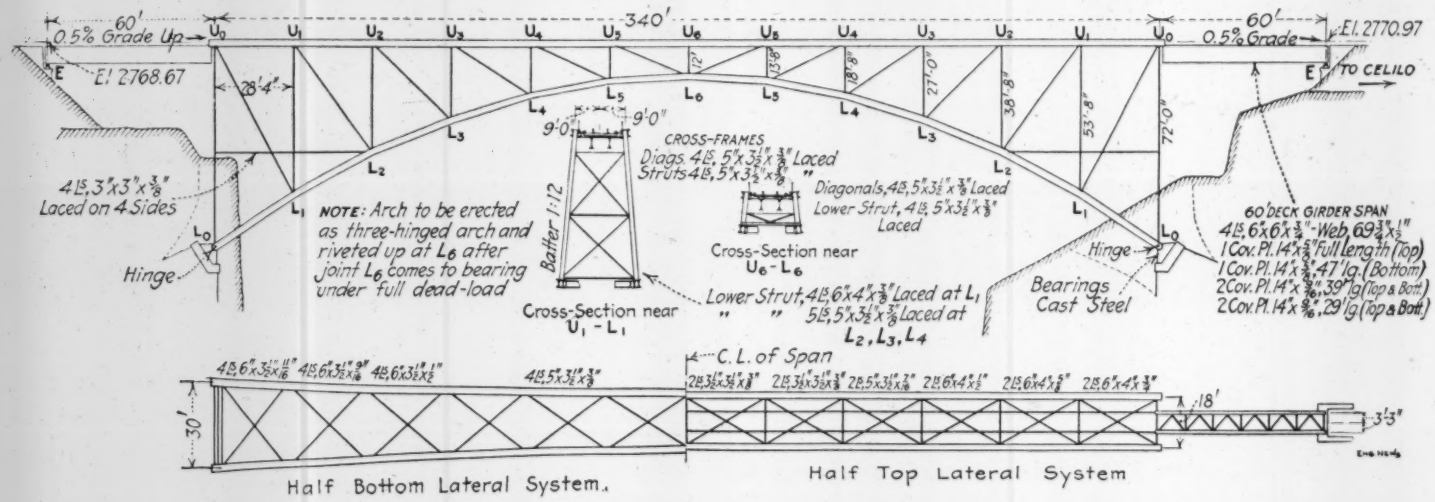


FIG. 3. OUTLINE DIAGRAM OF CROOKED RIVER ARCH

stresses acted as in a two-hinged arch. The finished structure is an extremely graceful and well proportioned span, set off with fine contrast by the ruggedness of its surroundings, as may be judged from the view Fig. 2.

FOUNDATIONS

In order to shorten as much as possible the delay to track-laying while waiting for the completion of the bridge, work on the foundations was begun in the fall of 1910, so that erection could begin as soon as track should be laid to the bridge site. To do this, all supplies, machinery and cement had to be freighted overland from Shaniko, the nearest railroad point, a distance of 65 miles. At 40c. per ton-mile, the cost of the cement was quadrupled and freight bills on the plant amounted to 100% of its original cost. Although the amount of concrete to be placed was small, the estimated volume of the four pedestals with their footings being only 265 cu.yd., yet in order to secure monolithic construction and uniform high quality of the concrete a machine mixer was decided upon. A ¾-yd. Ransome mixer, driven by a 12-hp. gas engine, was freighted in for the purpose. The balance of the plant consisted of a small McCully stone crusher, a double-drum hoisting engine and a 1¼-in. cableway, 450 ft. long. The latter, built on the center-line of the bridge, was used, first to hoist stone for the crusher and water from the bottom of the cañon, and later to deposit the concrete in the pedestal forms.

The excavation was slow and difficult, as the broken nature of the rock along the edge of the cañon above and the nearness of the pedestal sites to the cañon wall required light and careful shooting. On the south side of the cañon, where the wall is vertical for 300 ft., the rock was excavated about 15 ft. from the face of the cliff, for a width of 40 ft. and a depth of 50 ft. In addition to this, four shafts were sunk approximately 30 ft., through solid rock the entire distance, to take the anchorages of the erection device. There were two of these on each side of the cañon. The railroad did the work by force account, because of its inaccessibility and uncertain cost.

Crushed basalt stone and screenings were used for the 1:2:4 concrete of the pedestals, with reinforcement consisting of ¾-in. square Johnson bars, 12 in. on centers and 6 in. from the surface. The footings and shaft of the pedestals were each cast continuously, to avoid planes of weakness at the end of a day's work. Four of the six 2-in. anchor bolts were put in position before concreting, with provision for slight movement, the other two to be placed after erection of the shoes. The abutments which carry the ends of the 60-ft. girder approach spans were not built at this time, as they would come in the way of the erection device.

The distance between pedestals was determined by triangulation from an 828-ft. baseline laid out on the south side of the cañon.

ARCH DETAILS AND DESIGN

The structure is, as mentioned above, a two-hinged spandrel-braced arch (Fig. 3), with the dead-load stresses in the members (at 60°) those of a three-hinged arch. This condition was secured by bringing the two halves of the arch to bearing on a pin at the crown (see Fig. 4), and then placing the center top-chord section covering two panels, drilling its blank ends and riveting it up at a temperature of 60°. The span center to center of end bearings is 340 ft., divided into 12 panels. The spacing of trusses at the top chord is 18 ft. c. to c., and at the skewback pins 30 ft. c. to c., the trusses being battered 1 to 12. The depth of the truss is 12 ft. at the crown and 72 ft. at the ends. The bottom chord has the form of a

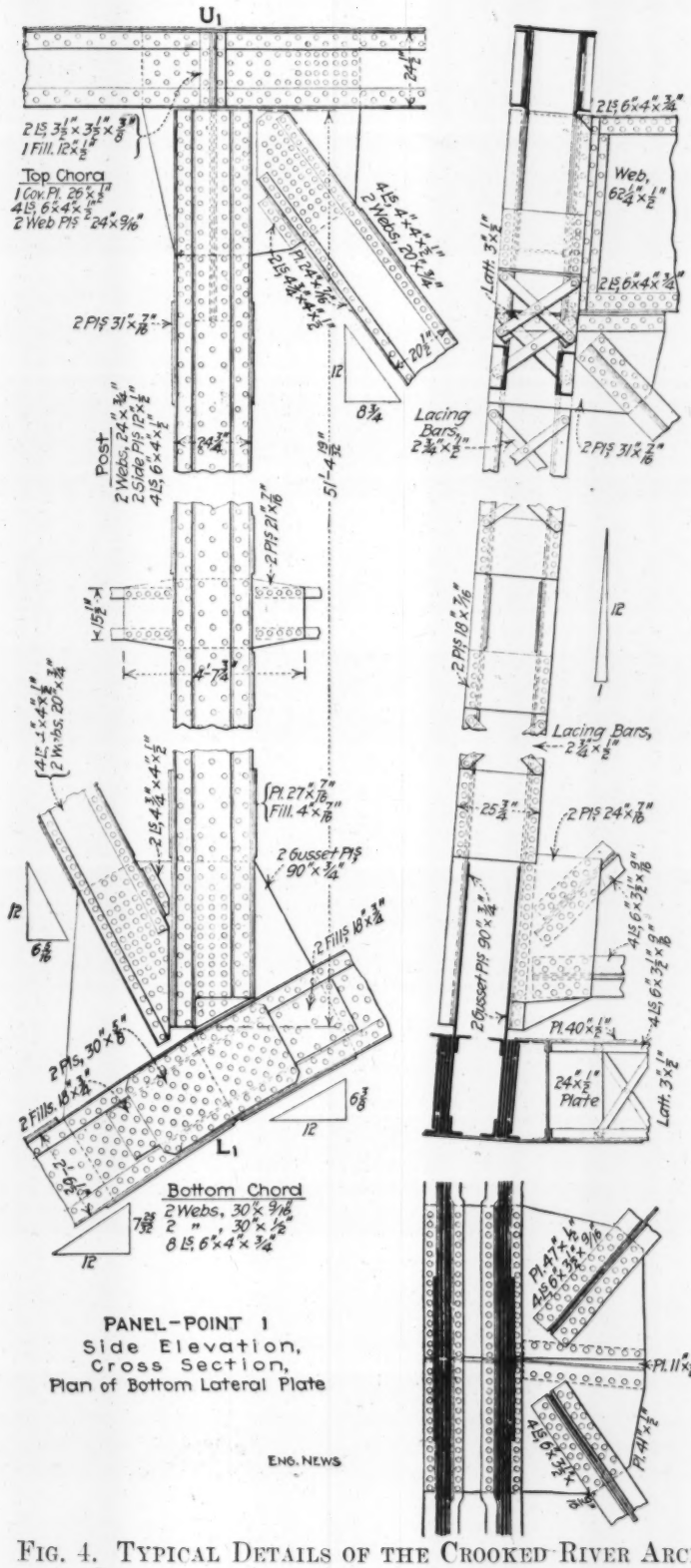
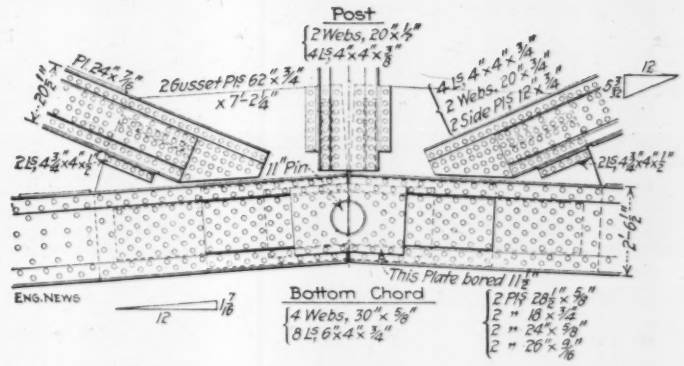


FIG. 4. TYPICAL DETAILS OF THE CROOKED RIVER ARCH

parabola. The connections throughout are riveted. All details were worked out with a view to ease of cantilever erection.

The loading used was that standard for all bridges on the Oregon Trunk: two 188.5-ton engines followed by 5000 lb. per ft. for the trusses, and one 214-ton engine followed by the same uniform load for the floor-system. The bridge is single-track.

A maximum area of 141.2 sq.in. is required in the bottom chord, in L_4-L_5, the section consisting of two built I-ribs with 30-in. webs, laced top and bottom with 5x$\frac{7}{16}$-in. bars. A large ¾-in. gusset-plate is shop-riveted to the outer end of each chord section for connection to the web members. Great care was taken in the shops to secure accurate facing of the ends of the sections. The



compression chords are field-spliced for 50% of the stress. Diagonals and posts are composed of two built channels, turned out, and are stiffened at the connection to top and bottom chord by longitudinal diaphragms transverse to the plane of the truss. The top chord is built up of two webs, cover-plate, and in the first two panels four angles; in the others, six. At the L_0 point, the hinge consists of a 13-in. pin resting horizontally on the three webs of the cast-steel shoe. The pin holes in the bottom chord are bored to the skew necessitated by the 1:12 batter. The shoes weigh 10½ tons each; they are set on a rust joint about 1 in. in thickness.

The floor-beams, 62½ in. in depth, connect to the inside webs of the posts just below the top chord, and rest also on brackets riveted to the posts (Fig. 4), which brackets in addition form the connection for the sway-bracing. The stringers, 48½ in. deep by 28 ft. 4 in. long c. to c. of floor-beams, connect into the webs of the latter with top flanges practically on the level of floor-beam flanges. They are without stiffeners or sway frames, being braced by their connections to the heavy top-lateral angles, which cross immediately above the top flanges of the stringers and rivet to them. At U_0 a cross-girder supports the end of the 60-ft. approach girder

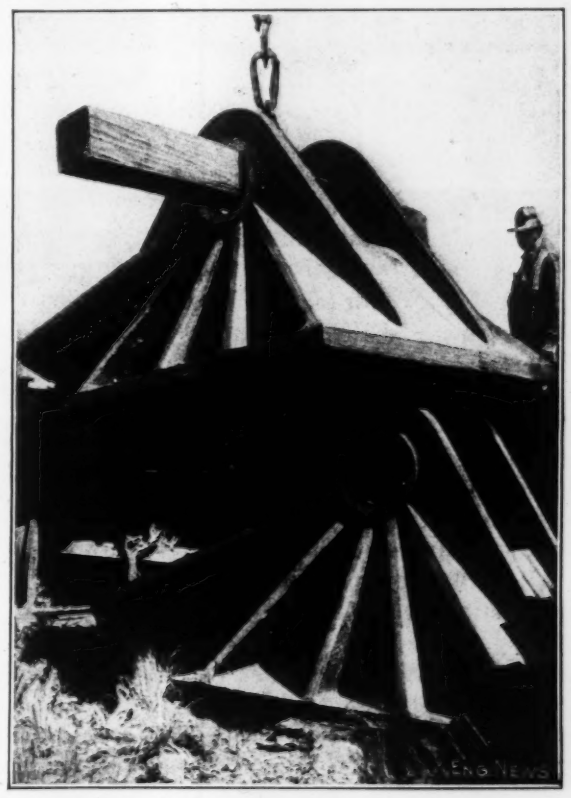


FIG. 5. CAST-STEEL END SHOES OF THE CROOKED RIVER ARCH, OREGON TRUNK RY.

spans, which are in turn provided with seats to take the shore ends of the stringers. Bottom laterals and sway-bracing are composed of four angles, laced to an I-section.

In order to raise the ties above the upstanding legs of the top laterals, a 5x12-in. sleeper is laid along the tops of the stringers. The ties are 8x10-in. Oregon fir, dapped

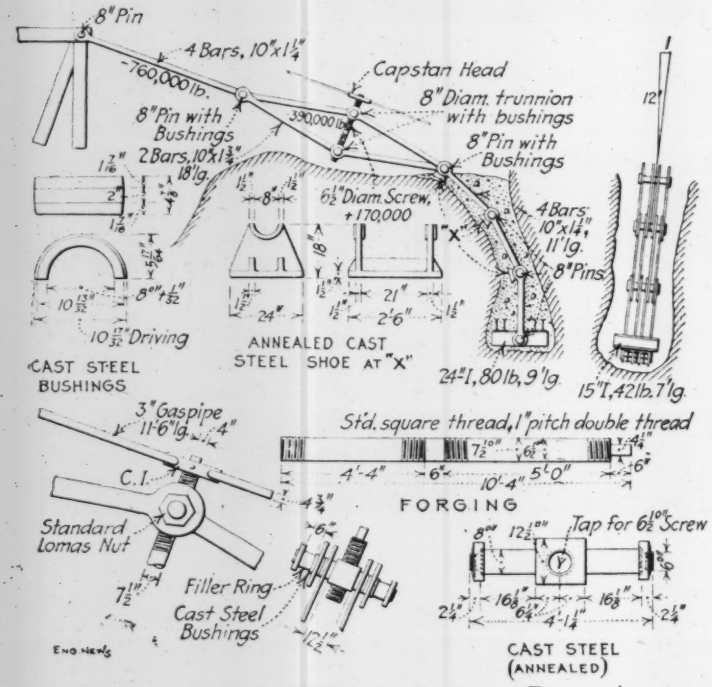


FIG. 6. ANCHORAGE TOGGLE, CROOKED RIVER ARCH

⅝-in. over the sleepers, 12 and 16 ft. in length, every fourth tie being long. Every second tie is bolted through sleeper and stringer-flange. The outer guard-rail is placed at the end of the short ties, over which it is dapped 1 in., and is bolted to every third tie. The long ties carry a 2-ft. plank walk outside the guard-rail. A ⅞-in. wire rope, supported by stanchions bolted to the top chord, serves as a hand-rail. The inner guard-rail is a 4x5x⅝-in. angle, with the 5-in. leg vertical, bolted through every tie.

ERECTION DEVICE

Anchorage during the cantilever erection of the two arms was provided by a strong and very simple erection device (Fig. 6), a chain of four 10x1¼-in. eyebars (giving 50 sq.in. to resist the maximum pull of 760,000 lb.), running down from the U_0 point at an angle of about 20° with the horizontal to the adjustment toggle, and thence in a curve to the grillages placed at the bottom of the anchorage shafts, the last set of bars being vertical in side elevation. The whole device was set in the plane of the trusses, i.e., battered 1:12 in end elevation. The grillage was composed of three 24-in. 80-lb. I-beams, pin-connected to the bottom eyebars, with four 15-in. 42-lb. I-beams resting transversely on their upper flanges. Cast-steel shoes were provided at each point of inflection in the curve to take the radial reaction, amounting to 145,000 lb.

The erection toggle was a parallelogram made of eight 10x1⅝-in. eyebars 18 ft. long, and was controlled as to length by a screw 6½ in. in diameter working through trunnions, on the short diagonal of the parallelogram. The screw was turned (see view Fig. 7) by eight bars engaging a capstan head fixed to the end of the screw. The joint pins of the toggle were 8 in. in diameter, but the eyebars were bored with 10½-in. pinholes, in which were placed steel bushings 4⅞ in. wide, turned for a driving fit in the eyebars, but bored with $\frac{1}{32}$-in. play on the pin. These were given before erection a heavy coat of solid lubricant, composed of one-third tallow and two-thirds lard, mixed with flake graphite to the consistency of thick syrup when melted.

After erecting this anchorage, the shafts were filled with 1:2:4 concrete for about 10 ft., and above that 1:3:6 concrete with one-man stone dropped in.

The toggle provided for 9⅞-in. change in length in the anchorage, corresponding to movement of the screw from 2 ft. 5 in. spread of toggle (extreme lowered position) to 8 ft. spread (extreme raised position). This was sufficient to raise the semi-arch at crown 15 in. or lower it 8 in. from the normal position, if required.

ERECTION TRAVELERS

A timber traveler of rather simple design (Figs. 8 and 9) was used by the contractor in the erection of the arch. Two were required, one for each arm. They were alike, except that the one used on the north arm had clearance under the engine deck for the derrick-car. As no car was used on the south side, the posts on that traveler were made 4 ft. shorter and the deck was placed just above the sills.

The travelers had a length over all of 76 ft., with an overhang of 32 ft., allowing the falls to be hung over any point in a panel. The two 8x16-in. sticks which composed each side of the jib were 18 ft. apart on centers, bringing the falls over the center-line of top chord. The sills were the same distance apart, the traveler rail being laid on the center of the top chord on short ties which were beveled on the lower side (on account of the batter of the cover-plate) and were kept in position by being dapped over the rivets in the cover-plate. Supporting the engine deck were six posts, framed to fit in

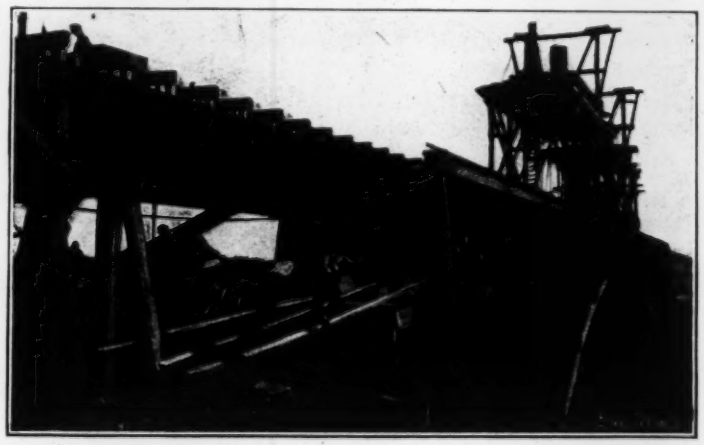


FIG. 7. ERECTION ANCHORAGE AND TOGGLE, CROOKED RIVER ARCH

between the sills at their lower ends, so that the blocking under the traveler could have end bearing on them. The two front posts, 12x14 in. in section, extended 22 ft. above the deck and were capped by a 12x14-in. stick 30 ft. long. On top of this cap were bolted the hardwood saddles to which the ends of the tie rods which supported the jib were bolted. These tie rods were of 1¾-in. round medium steel, with ends upset, and were placed two on

each side of the traveler. About 16,500 ft. b.m. of Oregon fir was required for each traveler. The estimated weight with full rigging, engine, coal and water was 45 tons.

Six tackles of 1¾-in. manila line, five-part and six-part, were hung from the jib of the north traveler, in line

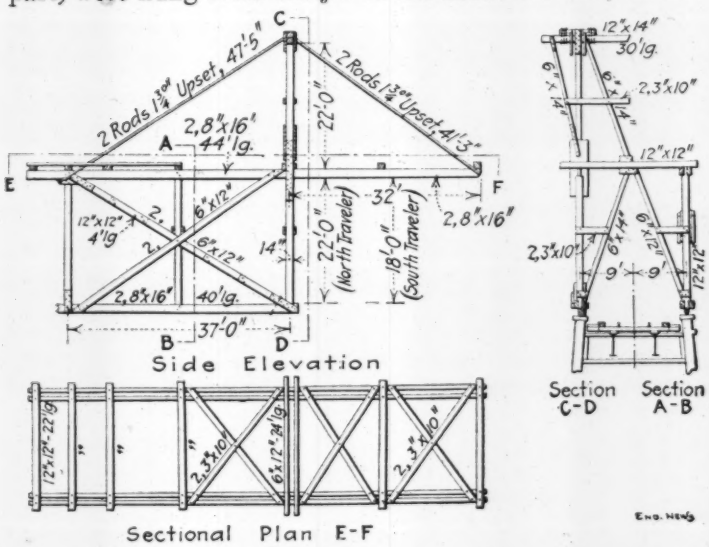


FIG. 8. CANTILEVER TRAVELER USED FOR CROOKED RIVER ARCH ERECTION

with the center of top chord. Material was handled from the derrick-car and drifted out to these tackles by a five-part tackle of ⅞-in. wire rope, which was hung at the rear of the boom over the center of track. Later, during the erection of the south arm, the manila falls were removed and a six-part falls, 340 ft. in length, of ¾-in. rope, was placed at the outer end of the jib to lower steel to the bottom of the cañon in transferring it to the south side. The two ends of this wire rope were attached to separate drums on the engine, giving greater speed in handling this long falls and an opportunity to cool one friction while lowering steel with the other.

On the south traveler the manila falls were rigged essentially as on the north side, and in addition a six-part wire tackle was hung in the center of the jib to raise material from the bottom of the cañon.

The derrick-car used to unload material and bring it from the storage yard to the north traveler was one of the contractor's standard cars, rated at 10 tons capacity, but able to handle the 14-ton endposts.

ERECTION

Preliminary work necessary before actual erection could be begun occupied the time from May 15, 1911, when the contractor arrived on the ground and began unloading steel, until June 23, when the first shoe was placed on the north side. This work consisted in preparing the anchorages (assembling the eyebars and grillages and filling the shafts with concrete), building trestle and falsework from the end of the grade to the span, and building the north traveler.

The falsework consisted of five-post bents of 12x12-in. timber, three posts to carry the track and an outer one on each side to support the traveler, except the last bent, in which were used five piles about 62 ft. long. On top of these bents were placed three pony bents, the inner one of three posts supporting the track, and the two outer ones of two posts each, supporting the traveler run.

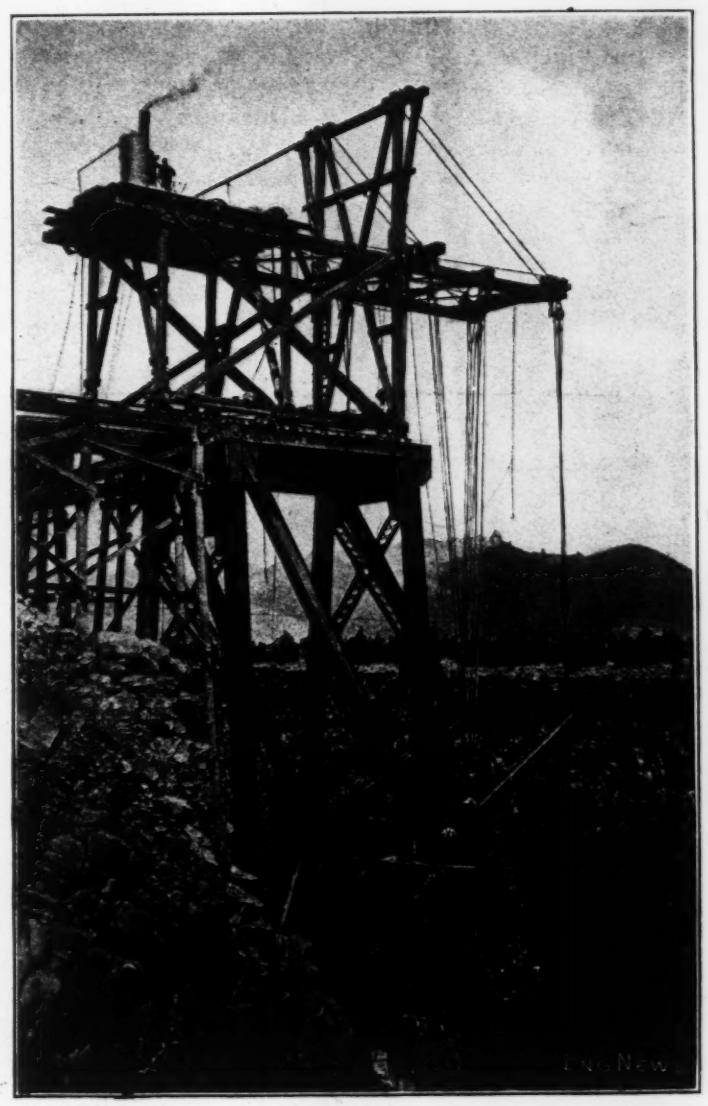


FIG. 9. WOODEN TRAVELER USED IN ERECTION OF CROOKED RIVER ARCH

Spacing of posts, height of cap, etc., in the bents varied, in order to allow clearance for the anchorage eyebars through the structure. These bents supported the traveler during its construction, and later, by removing the pony bents, allowed of the placing of the 60-ft. approach girder and supported its outer end.

The traveler was framed in the yards, and its sides, jib, top bent, etc., assembled as units on the ground, and later carried out and put together by the derrick-car.

After placing the second shoe, on June 24, 1911, the bottom chords were lowered and the L_0 pins driven. To drift the chords out to their position as required by the batter of the trusses, outhaul lines were run to points further along the cañon wall. The U_0-L_0 posts, which were 72 ft. long and weighed 14 tons, were then connected to the bottom chord, the temporary pins at U_0 connecting to the anchorage device driven, and the diagonal swung into place, making the panel self-supporting.

The shoes until this time had been carried on wedges and not accurately set in position; it had been found impracticable in the shops to check exactly the boring of the skew pinholes in the L_0-L_1 chords, and it was intended, in case these should prove slightly inaccurate, to shift the position of the shoe and its horizontal pin, to prevent unequal bearing on the webs of the chord. As a matter of fact, the shopwork proved very accurate and no

change was required in the position of the shoes. Before setting the pedestals on center-line, the distance across the cañon was checked by direct measurement with a steel wire, previously calibrated for a distance of 340 ft. unsupported. This method gave results agreeing very closely with the distance obtained by triangulation. A correction was also made for the difference between the shop and field standard tapes—which amounted to ¼ in. for this span. After setting the shoes in position, a rust joint was placed under them. This consisted of 1 lb. sulphur, 2 lb. sal-ammoniac and 233 lb. iron borings,

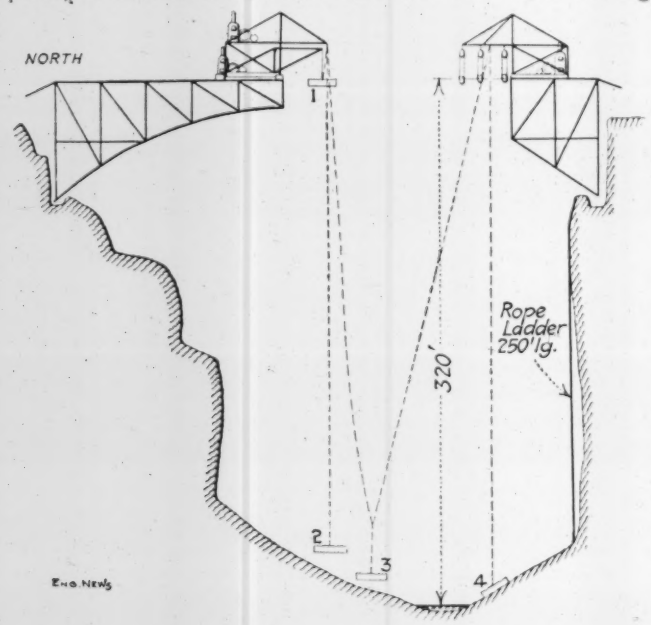


FIG. 10. SKETCH OF CANYON CROSS-SECTION, SHOWING METHOD OF TRANSFERRING STEEL ACROSS GORGE; CROOKED RIVER ARCH

thoroughly moistened, and was rammed evenly under the pedestals, the holes around the anchor bolts first being filled with grout.

The erection then proceeded with the placing of the U_1-L_1 posts and floor-beam, which was entered between the posts several feet below its position and then moved vertically up to position—the plates covering the brackets which riveted to its bottom flange being temporarily slid aside. Top chords, stringers and bracing were then placed and riveting begun.

It had been decided to rivet in each panel, as erected, all the principal truss connections except the bottom-chord splices. This was done because of the high erection stresses in some of the members and to keep down erection costs by reducing the number of bolts and drift-pins required, there being 17,000 rivets in the connections which were riveted at this time alone. Bottom laterals, sway-bracing and bottom chords were bolted up 50%.

Before running out the traveler and proceeding with the erection of the second panel, the toggle in the erection device was opened until its short diagonal was increased to 7 ft., corresponding to an elevation of the outer end of the semi-span of 9 in. The erection of the remaining panels proceeded, the truss members being placed in the same order as the first panel, and each panel being riveted before erecting the next. After the first panel had been placed, the remaining panels were erected in one day each, the riveting, with three gangs, taking an average of three days to the panel. Fig. 11 shows erection work in progress.

In order to reduce the erection weight, the sixth panel was not placed at this time; the fifth panel was completed on July 26, 1911 (see Fig. 1). During the next two weeks the contractor's force was engaged in setting the approach girders on the north side, completing the framing and erecting of the south traveler and falsework, erecting the south anchorage, and lowering the steel for the first three panels of the south arm into the bottom of the cañon.

The timber for the traveler, the engines and rigging, and the steel for the anchorage device, were all transferred across the cañon on the cableway which had been used in placing the foundation concrete. The profile of the cañon made possible the rather unusual method of transferring material to the other side shown by the sketch Fig. 10, using the tackles of the two travelers. The south wall rises vertically from a point within a few feet of the extreme bottom of the cañon, thus allowing the material to be drifted across the cañon with very long fall lines (and consequently slight horizontal pull on the travelers) and then hoisted vertically, after removing the holdback tackles, to the level of its final position, where the blocks of the side tackles were hooked into chains already attached, and the member was fleeted over into position. It had first been planned to transfer material across only as needed for erection, using much shorter falls and removing the holdback tackles while the piece was in the air. Consideration of the probable swinging of the load while being transferred, its racking effect on the travelers, the necessity of outhauling across the gap one set of tackles each time, and the fact that time would be saved by lowering steel for several panels to the bottom while erection was proceeding on the south side, prompted the choice of method used.

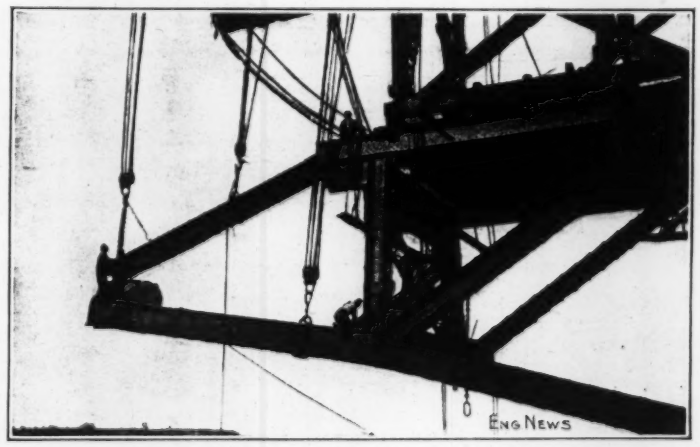


FIG. 11. SETTING ONE OF THE DIAGONALS, CROOKED RIVER ARCH

Very long six-part wire tackles were required, 2200 ft. of ¾-in. line being used on one side and 2300 ft. of ⅝-in. line on the other. Erection was very little delayed by the fact that material had to be transferred in this way.

A feature of the work which caused great local interest was a rope ladder, 250 ft. long, hanging free from the top of the undercut south cliff, and used by the men in crossing the cañon until the travelers came within reach of each other.

The south arm was started on Aug. 8 and finished through the fifth panel Aug. 31, an average of 1½ days

being spent in erecting each panel after the first one and two days in riveting. After the fifth panel had been erected, the diagonals and bottom chords of the two center panels were erected with the center pin in place in its half-hole in the end of one chord. Then the anchors were let down till the half spans came to a bearing on the pin, making the structure a three-hinged arch. Four or five men on each capstan easily lowered the arms under a tension of 500,000 lb. The remaining members of the panels were then dropped into place. The top-chord section, which was two panels in length, was about ¾ in. shorter than the opening at 60°. Both ends of this chord section had been left blank, and they were drilled after erection to match the splice-plates attached to the adjoining chords, at a temperature of 60°. One end was center-punched, drilled and riveted, after dividing up the opening at the ends of the chord equally at about 60° F., and the other end was then center-punched through the splice-plates at exactly 60°. One side of this splice was then riveted and the point left until a cloudy day, when the temperature of the steel was again 60°, when it was quickly riveted up. There were 1000 field holes to be drilled in these chord connections and in the post.

The railroad was naturally very anxious to begin laying track toward its terminus in Bend as soon as possible, and so the tracklayer and work train were sent over the bridge on Sept. 17, 1911, with the riveting only 50% complete—the bottom chords, laterals, sway-bracing and floor-system being unriveted, but well bolted and pinned. The remaining 21,500 rivets were driven in five weeks by three four-men gangs, using Thor hammers at a pressure of 100 lb. A Fairbanks-Morse gas-engine-compressor unit furnished the air.

The arch was designed and erected under the supervision of Ralph Modjeski, Chief Engineer of Bridges O. T. Ry., with W. R. Weidman Resident Engineer. Ralph Harris was Assistant Engineer during the foundation work, and the writer during erection. The steel was fabricated by the American Bridge Co., and erected by the Missouri Valley Bridge & Iron Co., of Leavenworth, Kan.; E. H. Barkmann was their engineer in charge, and J. J. Kelley their superintendent. Ralph Budd is chief engineer of the Oregon Trunk Ry.

❖

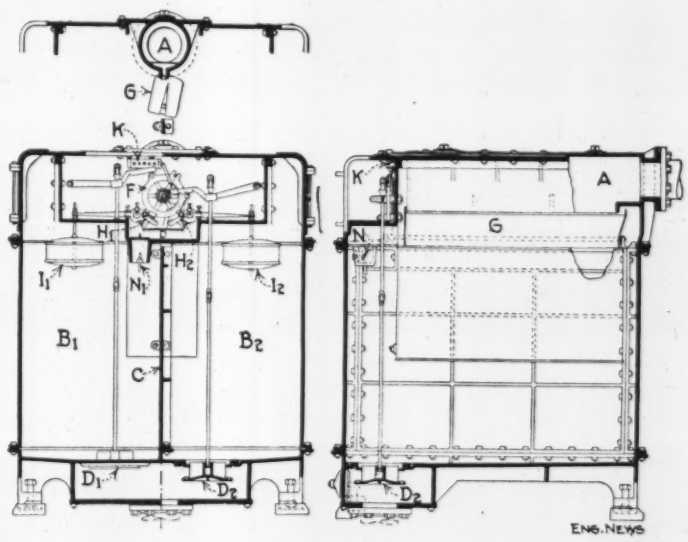
Macadamized Roads in New Castle County, Delaware, up to Jan. 1, 1913, aggregated 138½ miles, which is nearly 14 per cent. of the entire mileage of roads in the county. Since the passage of the first State good roads law by the Delaware Legislature in April, 1903, there has been spent on the construction of stone roads in New Castle County, $1,206,780. This makes the average cost per mile for construction $8715. The above figures are taken from the report of the New Castle County State Highway Commissioner, Francis A. Price.

A Motor Truck Reliability Run is to be held under the auspices of the Washington "Post," on May 5-8. This contest, which is held under the rules and sanction of the American Automobile Association, will cover a distance of 325 miles, starting from Washington, D. C., and passing through Frederick and Hagarstown, Md., Shippensburg, Harrisburg, Lancaster, Gettysburg, Penn., and Baltimore, Md.; back to Washington. Twelve classes of trucks will compete, the classification being by carrying capacity, and the average speed for each class is prescribed. A grand trophy consisting of a large silver vase is to be awarded for the best score of all entered and division trophies will also be given for the best score in each class. The scores will be determined on the basis of penalties for repairs, lateness, failure of fuel supplies or batteries, replacements, stops, and on the economy of operation. A pamphlet giving full directions and rules has been issued by the Washington "Post," together with entry blanks for the contest.

A Liquid Meter of the Measuring Tank Type

For the most accurate measurement of liquids, where weirs, flumes, orifices, or commercial water meters are to be calibrated, the common plan is to measure the amount of water or other liquid in tanks which are alternately emptied.

A liquid meter which operates on the above principle, the tanks being automatically emptied when full, has been put on the market recently by the Alberger Pump & Condenser Co., of New York City, and is known as the Hammond meter. The accompanying sectional views make clear its method of operation.



FRONT AND SIDE SECTIONAL ELEVATIONS OF AN AUTOMATIC CONTINUOUS LIQUID METER OF THE MEASURING TANK TYPE.

The meter has a cast iron built-up box case with an inlet pipe at the rear near the top and the outlet in front at the bottom. The liquid to be measured flows first into receiving tank A from which it escapes through a narrow slit in the bottom. The flow from this slit is directed into either tank B or B_2, according to the position of the deflector G. Assuming it to be B_1, this flow continues until the liquid just closes over gage N_1. At this instant the upward pressure on float I_1 releases the latch at H_1, and the downward pressure on discharge valve D_1 rotates the wristplate F to a latched position at H_2, closing discharge valve D_2 and throwing deflector G to the left. The motion of the wristplate also registers one count on the recorder K. The opening of valve D_1 permits the contents of tank B_1 to discharge. The same process is repeated now on the other side, measuring tank B_2 being in service while B_1 is discharging. A similar gage N_2 (not shown) marks the maximum height of fluid in measuring tank B_2.

The operation of the meter is automatic and continuous and it is guaranteed to register with an error of not over 1% at any rate of flow up to its capacity, when properly cared for and when the liquid is at the temperature for which the meter is calibrated.

While of course much more bulky and costly than ordinary types of flow meter, it can be used for hot and corrosive fluids for which such meters are of doubtful accuracy.

Novel Tunnel Work on the Cleveland Short Line Ry.

The double-track freight cut-off line built by the Lake Shore & Michigan Southern Ry. around the south side of the city of Cleveland, Ohio (from Newburg to Collinwood), and known as the Cleveland Short Line, presents some interesting features in its two tunnels: 1, they were built in open cut and backfilled; 2, one of them has an

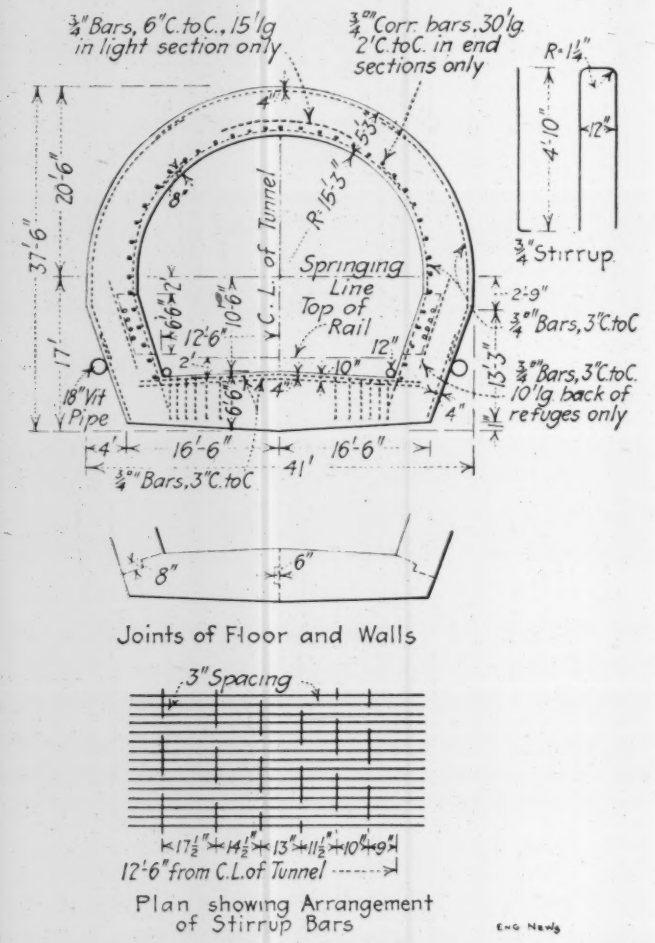


FIG. 1. TUNNEL ON THE CLEVELAND SHORT LINE, WITH HEAVY REINFORCED-CONCRETE LINING

extremely heavy lining of reinforced concrete; 3, the other has two sewers carried through the crown by steel trusses embedded in concrete. A considerable part of the line is kept below the level of the ground in order to avoid grade crossings of the streets and of the several railway lines intersected. At two points in a long cut, tunnels were required under railway yards and manufacturing sites, and as the depth of cover would be relatively slight and the district had not been built up at that time, the opportunity was taken to reduce the cost of construction by building the tunnels in open cut and then backfilling over the masonry. The excavation was done by steam shovels.

TUNNEL WITH HEAVY LINING

The larger tunnel, 775 ft. long, passes under numerous railway tracks and under a site to be occupied by a new plant of the American Steel & Wire Co., where heavy machinery would be operated, and in order to prevent injury to the tunnel by the shocks and continual vibration a very thick concrete lining is used, heavily reinforced by steel bars. The cut here is in gravel and water-bearing sand. The tunnel is of horseshoe shape, 25 ft. wide at the floor and 30 ft. 6 in. at the springing line, with a roof radius of 15 ft. 3 in. and a height of 25 ft. 9 in. at the middle or 23 ft. 9 in. above the rails. The cross-section and the arrangement of the reinforcement are shown in Fig. 1. In the heaviest section of the tunnel, the lining is 5 ft. 3 in. thick at the arch and 6 ft. 6 in. at the center of the floor. Toward one end, the thickness at these points is 4 ft. 9 in. and 5 ft. 9 in., respectively. The steel bars are laid near the inner and outer faces of the concrete, and 4 in. from the surface, except that on the inner face of the arch this distance is increased to 8 in. to insure ample protection for the steel after erosion of the concrete by the blast of the engines. The longitudinal bars are used only in the end sections. In the floor, there is a double layer of bars, 4 in. and 10 in. from the surface, while the sides of this massive floor slab are reinforced by vertical steel stirrups, as shown. In the lighter section of the lining an aditional set of transverse bars is used at the crown, as indicated by dotted lines. Most of the reinforcement consists of corrugated bars ¾ in. square.

The floor slopes from the center to the sides, where 12-in. drain tiles are laid in the ballast, and on the outside are two lines of 18-in. drains, which extend through the portals. All these are vitrified pipes. To accommodate signal, telegraph and other wires, four lines of 4-in. wrought-iron pipe, spaced 12 in. apart, are embedded in the concrete on each side of the tunnel. On each side also there are refuges 50 ft. apart (staggered on opposite sides); these are 2 ft. deep, 2½ ft. wide and 6½ ft. high. As the face reinforcement is necessarily omitted at these points, lines of steel bars are placed at the back of the recesses, as shown.

The concrete lining is built in lengths of 30 ft., with tar-paper expansion joints between them, and the longitudinal bars of the end sections are therefore 30 ft. in

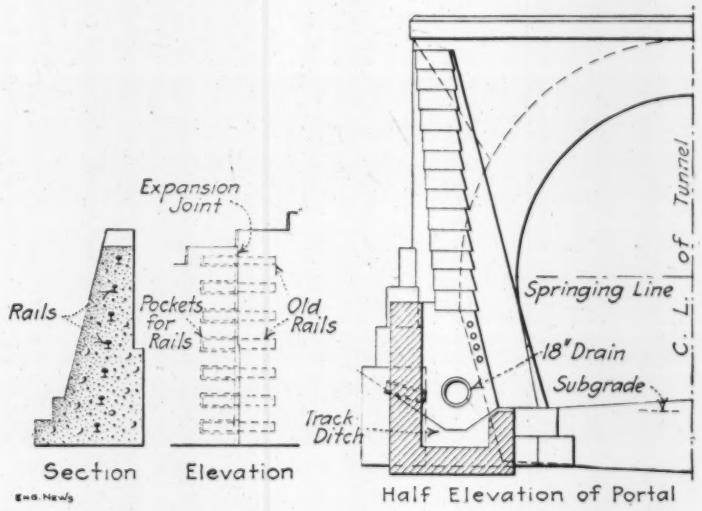


FIG. 2. PORTAL AND EXPANSION JOINT IN WING WALL OF TUNNEL: CLEVELAND SHORT LINE

length. Near the north portal, a line of 54-in. cast-iron pipe crosses the arch, extending 20 in. below the outer surface, and the circular bars are bent to keep 4 in. clear of the pipe. Two smokestacks or ventilating shafts are provided, extending from the crown of the arch to the surface. Each of these is 4 ft. inside diameter, with an 18-in. concrete wall reinforced by vertical bars, and having the top fitted with a cast-iron grating bolted down. The north portal is shown in Fig. 2, with the masonry

sump and track ditch and also the wing wall. At this portal one of the wing walls is of such length (92 ft.) as to have an expansion joint. At this joint, pieces of old rail 7 ft. 5 in. long are embedded in the end nearest the tunnel, while the projecting ends lie in pockets formed in the adjacent portion of the wall so as to permit of free expansion movement.

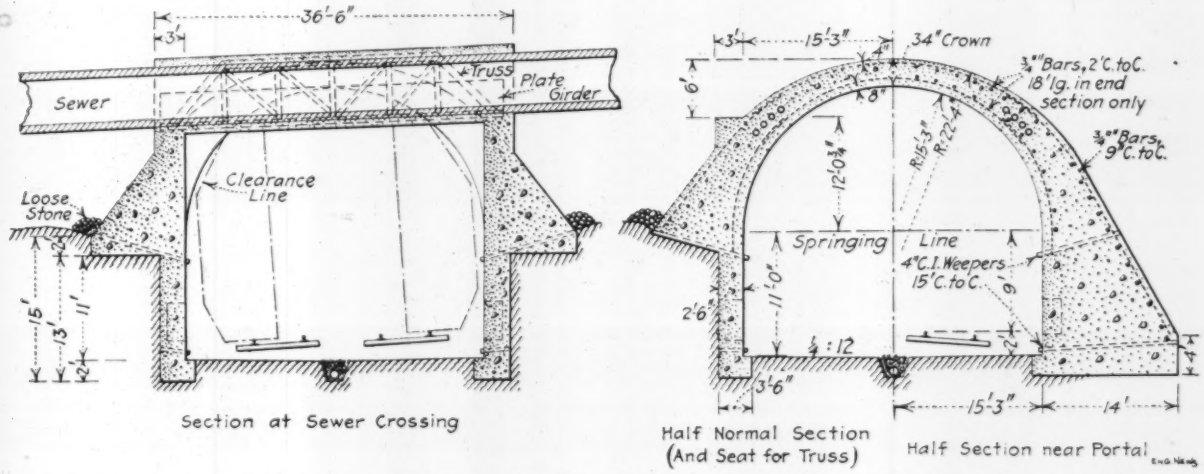


FIG. 3. CROSS-SECTIONS OF TUNNEL HAVING ITS LOWER PORTION IN SOLID ROCK; CLEVELAND SHORT LINE

The concrete is 1:2:4 for the lining and parapets, and 1:2:5 for the wing walls. It was required that the exposed surfaces should have a dense and smooth face, and that the other surfaces should not show honeycombing. In the construction of the lining, the floor was built in two parallel parts connected at the middle by a key or tongue-and-groove; the width of this is 6 in. and its depth is one-third the floor thickness. The side walls also are recessed into the floor for half their width and to a depth of 8 in., thus giving a shoulder to resist external thrust. This arrangement is shown in Fig. 1. The concrete was mixed at a stationary plant and delivered by dump cars on narrow-gage industrial tracks. For the floor the concrete was dumped directly from the cars. For the side walls, the bodies were lifted by a locomotive crane and dumped into the forms. For the roof, the bodies were lifted in the same way, but the concrete was dumped into small push cars running on a track laid over the forms on the center line of the tunnel. The railways crossing the line of the tunnel were carried temporarily by plate-girder spans on pile bents, while a suspension bridge was thrown across the cut for pedestrian traffic; this was 240 ft. span, with anchorages 500 ft. apart.

TUNNEL CROSSED BY A SEWER

The other tunnel is where the line crosses Broadway, and has a length of 345 ft. It is of very different section from the one first described, owing to the fact that it is mainly in solid rock below the springing line, so that only a thin lining is required at the sides and the rock is dressed to form the floor. This floor has a slope of ¼ in. per ft. to the center, where there is a trench having a tile drain and stone filling. The upper surface of the rock is shaped to form a bearing for the roof arch, but near the portal the concrete is carried down to a broad footing at the floor level. These sections are shown in Fig. 3. The arch is 34 in. thick at the crown, and is reinforced by transverse rods near the upper and lower faces, while longitudinal rods are used also in the end sections. The lap of the bars is specified to be 50 times their least diameter. The arch is built with expansion joints 30 ft. apart and filled with tar-paper, and the refuges are of the same size and spacing as in the other tunnel. The outside of the arch was given a waterproofing coat of pitch. For the signal and other wires there are four 4-in. pipes laid on each side of the crown.

At Broadway, the tunnel arch intercepts an oval brick sewer, 56½x44⅜ in., and a 2-ft. pipe. The grades could not be changed, and the sewers are therefore carried across the tunnel by a steel structure incased in concrete. There are two trusses 36 ft. long and 7 ft. deep, on opposite sides of the brick sewer, while outside of the pipe is a plate-girder, held in place by horizontal

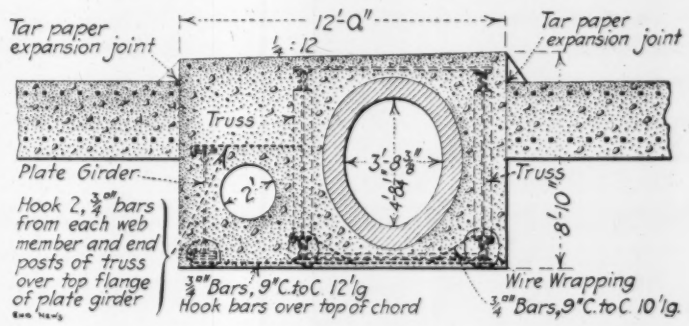


FIG. 4. SEWERS CARRIED ACROSS TUNNEL BY A STEEL STRUCTURE ENCASED IN CONCRETE: CLEVELAND SHORT LINE

rods hooked over its top chord and to the posts and diagonals of the adjacent truss. Transverse steel rods are laid over the tops of the trusses and beneath the girder and trusses, and other rods beneath the sewer are bent up to have their ends hooked over the tops of the bottom chords. These chords (for the trusses and girder) are wrapped with wire mesh for their entire length. The entire structure is incased in concrete, forming a block 8 ft. high and 12 ft. wide, extending about 3½ ft. below the crown of the tunnel, as shown in Fig. 4. Its top is given a lateral slope of ¼ in. per ft. for drainage, and the sewer has a grade of 3.5% across the tunnel. The trusses rest upon seats formed on the back of the tunnel arch, but between them the arch is omitted and the side walls are carried up to meet the bottom of the sewer casing, which forms the flat roof, as is shown in Fig. 3.

Temporary Hypochlorite Plant for Treating the Sewage of Norristown, Pa.

By S. Cameron Corson*

Several months ago there was a serious break in one of the large water-supply pipes of Philadelphia, which necessitated the temporary pumping of water directly from the Schuylkill River into one of the water-works reservoirs of that city. About that time there were some 25 cases of typhoid fever in Norristown. All of the sanitary or house sewers of Norristown drain into one intercepting sewer, which empties into the Schuylkill River at a point near the mouth of Saw Mill Run, at the lower end of Norristown.

The State Department of Health at Harrisburg desired that all the municipalities and large manufacturing plants along the Schuylkill should erect some kind of a temporary plant by which their raw sewage could be treated with hypochlorite of lime, and thereby eliminate many of the typhoid-fever germs. Our town council granted this request and the writer was instructed to erect a temporary plant.

Having ascertained the daily flow from this intercepting sewer to be about 1,250,000 gal. per 24 hr. and being requested by the State Department of Health to use at least 100 lb. per 1,000,000 gal. per day, this little plant shown in the accompanying sketch was arranged.

The five hogsheads, *A-B-C-D-E,* are connected together by a 2-in. galvanized-iron pipe and over the manhole there is a shutoff valve, which is set to drain the five hogsheads in 12 hr. The other set, *1-2-3-4-5,* are similarly connected and they are operated the second half of the day.

In the shed which covers the 10 hogsheads, paste barrel and supply drum is a stove to prevent the pipes and barrels from freezing, but this stove is only fired when the thermometer registers 24° F. or under.

The hypochlorite of lime is purchased in quantities of 3000 lb., in 500-lb. drums, at a cost of $1.83 per 100 lb., f.o.b. cars, Norristown, Penn. Recent quotations per 100 lb. f.o.b. Norristown, are $1.52 with a time delivery reserve and $1.63 for two weeks from order. The price of $1.83 was paid to a local drug house. These prices are from different companies.

The cost of operating the plant per day has been as follows: Laborer, 13 hr. at $0.175—$2.28;† 100 lb. of hypochlorite of lime at $1.83; total, $4.11 per day.

The total first cost of the plant was:

12 hogsheads	@ 75c.	$9.00
Two buildings, 8x16 ft. and 6x8 ft. (hemlock, covered with three-ply roofing felt)		45.00
Two stoves, $12 and $6		18.00
Water pipe, spigot connections, plumbing, etc.		13.00
		$85.00

The inspectors of the State Department of Health make almost daily visits and fill a bottle with raw sewage from a manhole next above the manhole at this plant, and also fill a bottle from the treated effluent at the mouth of the sewer. The writer is informed that the laboratory tests [made in Philadelphia several hours later.—Ed.] are satisfactory.

*Borough Engineer, Norristown, Penn.

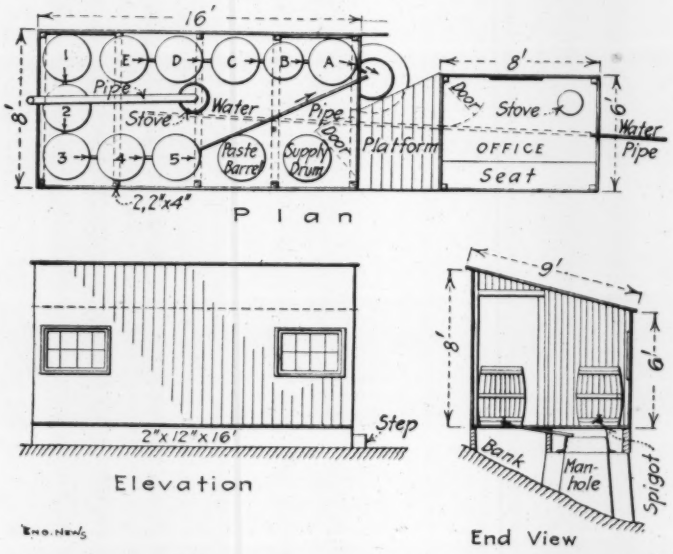
†It is necessary to have this man at work this length of time to insure better work, to keep the pipes between the hogsheads open, the materials well stirred and the outlet spigots open.

The small house used as a shelter for the caretaker is purposely kept away from the open manhole and the lime house for his better protection. The powdered hypochlorite of lime is measured for one dose, then placed in the supply barrel, where a sufficient amount of water is added to bring it to a consistency of thick paste. This is then dipped into the barrels to be charged, placing about 15 lb. of the paste in each barrel, but experience has shown that we get the best results by not having any of the lime in the last barrel, marked on the sketch "A" or "5."

The ¾-in. water-supply pipe is brought directly from the street main and is in constant use. While one battery of barrels is draining out into the manhole the other is being refilled.

The stream from the shut-off valve is so arranged that it falls on an old tin grater and the perforations of this grater distribute the solution uniformly over the sewage down in the sewer.

The sewer at this point is 27 in. in diameter, the depth of the sewage averages 6½ in. and the distance from the



Temporary Hypochlorite Plant for Treating Sewage of Norristown, Penn.

spigot to the surface of the sewage is about 8 ft. The distance from this manhole to the outlet of the sewer is 225 ft., and the grade is about 0.25%.

When we first erected this plant it was to temporarily carry out the request of Dr. Samuel G. Dixon, Commissioner of Health, and the plant was of the very crudest. We have since learned that we are expected to treat the sewage until the proposed new sewage-disposal plant is in operation, and more permanent arrangements have been made. The writer would suggest to any who may be forced to treat sewage, as we have been, to at once install small concrete vats or tubs, for the reason that within a few months we have had to renew several hogsheads entirely and put on new hoops on all of the others. In some we have put in concrete linings and if we must continue this treatment indefinitely, or until such time as our proposed disposal plant is in operation, we will be compelled to put in concrete tubs

George W. Fuller, 170 Broadway, New York City, as consulting engineer for Norristown, has recently submitted a report on a sewage-treatment plant to the State Board of Health.

New Ultra-violet Ray Lamps*

The development of the studies of the chemical and biological reactions produced by ultra-violet rays shows that there is a great need (if commercial processes are to be developed) for a lamp having an ultra-violet radiation much more powerful than from the usual 110 to 220-volt mercury lamp. In the lamps which have been heretofore used the electrodes have been placed on two ends of a straight luminous tube. These lamps often have bulb ends which form cooling or condensation chambers, and tend to reduce the effective luminosity. Messrs. Heilbronner and Recklinghausen have produced a new lamp which has the following modifications: (1) the luminous tube is given the form of a U-tube; (2) the two electrode ends of the tube are brought to the same side of the lamp and as near as possible to one another; (3) the voltage is increased. The lamp which they have recently presented before the French Academy of Sciences contains, as the luminous part, a quartz U-tube in which the two branches are brought together almost touching one another. The interior diameter is about $\frac{5}{16}$ in. and the length of each branch is 4 in. The two mercury electrodes are joined one to the other. This lamp burns on a 500-volt system with a difference of potential at the electrodes of from 375 to 390 volts, with a current of 3 amp. This tube consumes, therefore, 1150 watts. In a plane perpendicular to the axis of the lamp passing through the middle of the arc the lamp has an average candlepower of about 8000.

In testing this lamp the effect on various chemical and bacterial compositions has been noted in comparison with the action of an ordinary ultra-violet ray lamp on 110 volts. The results of the tests are as follows:

(1) Action on starch: The same reaction was obtained with the new lamp in six hours as was obtained with the 110-volt type lamp in 260 hours.

(2) Action on glycerine: The same action was obtained in 4 hours with the new lamp as was obtained in 240 hours with the old lamp.

(3) With the 500-volt new lamp, a polymerization of carbon and hydrogen compounds was accomplished in a very definite fashion, whereas with the 110-volt old type lamp the action was very limited.

The tests on the bactericidal properties of the two lamps were as follows: It was found that the sterilization of B. coli with the new type lamp was obtained 60 times as fast as with the 110-volt old type lamp. In comparing the time it took to kill certain growths placed under a 220-volt lamp, burning with 156 volts at the tube electrodes and 3½ amp., with those under a 500-volt lamp, burning with 397 volts at the tube and 3 amp., it was found that the relation was about 11 to 1, the higher powered lamp being more effective. On the other hand, the 220-volt lamp had a bactericidal action 5 times more tense than 110-volt lamp. In consequence, it can be figured that the 50 volt lamp is 55 times more active than the 110-volt lamp.

Summing up, the new lamp possesses an ultra-violet radiation 50 to 60 times more intense than a 110-volt lamp burning with 75 volts at the tube and 3.4 amp. The relative consumption of the two lamps is about 1 to 4.0.

*Abstracted from an article in "La Technique Sanitaire et Municipale," of Paris, February, 1913.

In testing the life of the lamp, it has been found in one urban installation that with four units, each containing two 500-volt lamps, the whole plant has been in operation more than 1200 hours, and so far as could be observed by the effect on sensitized paper the luminosity of the eight lamps has not changed in all this time. It is proposed to use this new lamp in water sterilization for large installations.

An Old Time Overshot Waterwheel

Thirteen years ago, in our issue of Dec. 21, 1899, we published a double inset sheet giving views of some of the old-time waterwheels in northern New Jersey, many of which, though long out of use, were then still to be seen.

We illustrate herewith an old-time waterwheel in Connecticut which has done service for probably more

AN OLD OVERSHOT WATERWHEEL AT SOUTH WINDHAM, CONN.

than 75 years, and though now displaced by a modern turbine is still in perfect condition. The wheel is located at the paper goods mill of the Smith & Winchester Manufacturing Co., at South Windham, Conn. The business of this company was established in 1828 by the father and uncle of the present senior partner, who is now 73 years of age. According to his best information the original wheel was first constructed at least 75 years ago. The arms and rim and buckets were renewed 45 or 50 years ago and the rim and buckets were again renewed about 20 years ago.

It seems not unlikely that this wheel may be the oldest prime mover in this country still in use or in condition to be used. It seems reasonable to believe that no steam engine built prior to 1838 can be still in use anywhere on this side of the water; and nearly all the overshot waterwheels of old-time construction which remained in use in New England and the Middle States were abandoned when the American turbine became popular twenty-five years and more ago. If any correspondent knows of any older prime mover in this country, we shall be glad to hear of it.

We are indebted for the above information to Mr. A. J. Ellis, Junior Geologist, U. S. Geological Survey.

A Large Reinforced-concrete Girder Bridge

By Harry J. Rodgers*

A reinforced-concrete bridge of a type well adapted to country-highway service has recently been completed across the Iowa River, near Marshalltown, Iowa, for the county supervisors of Marshall County. The bridge is 182 ft. long with a roadway width of 16 ft., and is made up of four similar 42 ft. 2 in. girder spans, resting on slender wall piers. Details of the design are shown in Fig. 1 and a view of the bridge nearing completion in Fig. 2.

to the bottom of the girders, but the two upper layers are bent up through the top of the girders, near their ends, to take the diagonal shear, and are embedded in the deck slab. Each girder is also reinforced vertically, and tied to the deck, with twenty-four ½-in. round shear stirrups, spaced 3 ft. c. to c. in the middle of the girders, the spaces contracting to 8 in. at the ends of the girders.

The floor slab is 6 in. thick. It is reinforced near the top and bottom with transverse ⅝-in. round bars, set 7½ in. c. to c., and with three longitudinal ½-in. round bars, placed near the bottom of the slab between the girders. The longitudinal bars in the girders and slab of the central spans overlapped above the middle pier. It carries an ordinary macadam road.

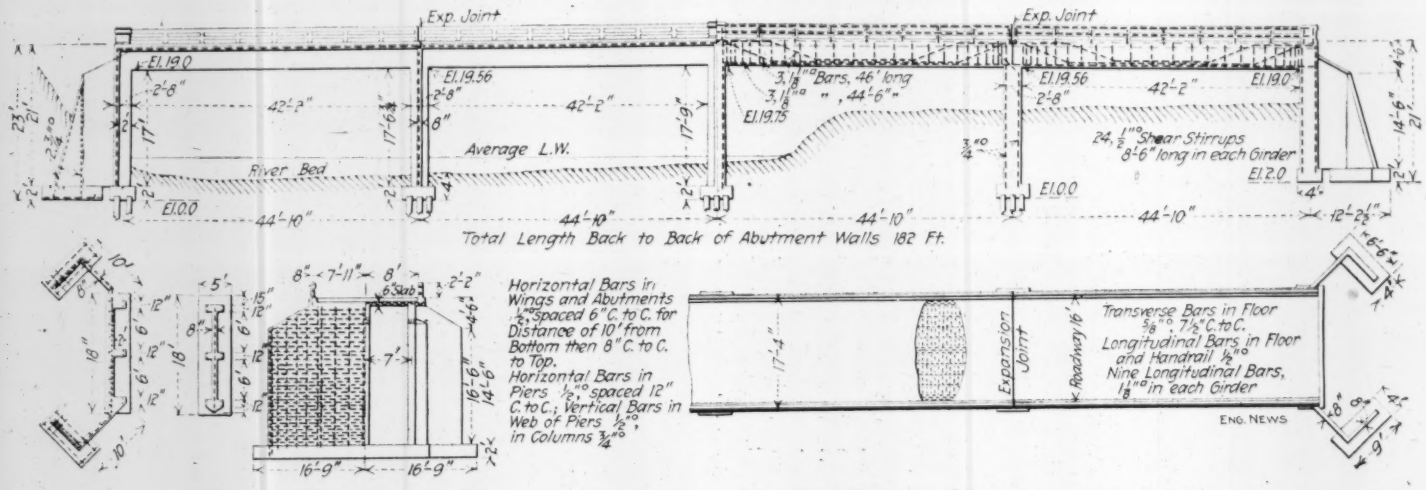

Exp. Joint
El. 19.0
El. 19.56
Average L.W.
River Bed
El. 10.0
42'-2"
44'-10"
Total Length Back to Back of Abutment Walls 182 Ft.
3, 1⅛" ⌀ Bars, 46' long
3, 1⅛" ⌀ " , 44'-6" "
El. 19.15
24, ½" ⌀ Shear Stirrups 8'-6" long in each Girder
El. 12.0
Horizontal Bars in Wings and Abutments ½" ⌀ Spaced 6" C. to C. for Distance of 10' from Bottom then 8" C. to C. to Top. Horizontal Bars in Piers ½" ⌀ spaced 12" C. to C.; Vertical Bars in Web of Piers ½" ⌀, in Columns ¾" ⌀
Transverse Bars in Floor ⅝" ⌀ 7½" C. to C. Longitudinal Bars in Floor and Handrail ½" ⌀ Nine Longitudinal Bars, 1⅛" ⌀ in each Girder
Expansion Joint
Roadway 16'
ENG. NEWS

Fig. 1. Details of Reinforced-concrete Girder Bridge, Marshalltown, Iowa

The three piers are similar in design, though the middle one is slightly higher than the others to provide a camber to the whole bridge. Each pier is composed of three 12x32-in. columns, which are braced and tied together by 8-in. web-walls. These webs extend from the foundation to the bottom of the deck slab, and they are reinforced horizontally and vertically with ½-in. round bars, set 12 in. c. to c. both ways, and wired at intersections. The columns are reinforced with ¾-in. round bars placed one in each corner, and banded with ¼-in. bars, spaced 12 in. c. to c. Upstream nosings were poured as a part of each pier.

The piers stand on foundations 2 ft. deep, 5 ft. wide, and 18 ft. long. The bottoms of the foundations in the channel are 4 ft. under the bed of the stream. Each foundation rests on a footing of nine piles. The vertical reinforcing bars in the columns and web-walls penetrate the foundations, and those in the center pier, the abutments and the fixed side of the intermediate piers extend up into the girders and floor.

The abutments consist of the typical column and wall construction with additional wing-walls, shown in Fig. 1, for holding the earth fill. These walls are 21 ft. high, 10 ft. long and 8 in. thick, and are reinforced with ½-in. round bars. They were poured monolithic with the abutments and were anchored at the ends to a counterfort on the rear of each wall. The counterforts and ends of the walls rest on footings 9 ft. long, 4 ft. wide and 2 ft. deep.

Each span is composed of three 12x36-in. girders, spaced 7 ft. c. to c. The main reinforcing of the girders is nine 1⅛-in. square bars, placed in three layers near the bottom of the section. The lowest layer extends parallel

*Marshalltown, Iowa.

The hand-rails are 30 in. high. They are composed of two 6x6-in. concrete bars, supported by 6x6-in. concrete posts at intervals of 4 ft. 5 in. Each bar and post is reinforced with two ½-in. round bars.

A joint, cut through the guard-rails, deck and girders over the center of the abutment-piers, provides for linear expansion, as does also a slip-joint between the under side of the girders and the top of these piers. A 6-in. fill of earth covers the deck, and a drop of 9 in., center pier to abutments, drains the roadway lengthwise of the bridge.

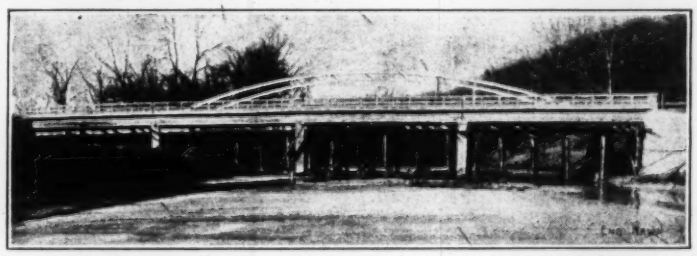


Fig. 2. View of Marshalltown Bridge across the Iowa River

Labor and materials were used economically in pouring concrete and in making and erecting forms. Concrete for the foundations was discharged by chute from the old bridge, alongside of which the new one was built, into coffer-dams.

The falsework was supported by six bents of piles to each span, with three piles in a bent. Each bent was capped transversely with two 3x12-in. sticks, 16 ft. long, bolted to the top of the piles. On top of these caps were longitudinal stringers, each one composed of three lines of 3x12's on edge, placed directly beneath the girder

forms. On these stringers there were laid transversely 3x12's, 24 ft. long, spaced 3 ft. c. to c. The girder forms were supported and trued by driving wedges between the bottom of the forms and these transverse planks.

While the falsework was being erected, the forms for all the columns, sides and bottoms of the girders were made in panels on the shore. As soon as the falsework was up the panels were ready to set in place. The forms were of 1-in. lumber, nailed to 2x4-in. cleats, spaced 2 ft. c. to c. This left them in shape to be taken down quickly, moved easily and erected for the next job with a minimum amount of waste of lumber and labor. None of the concrete for piers or abutments was poured until the girder and deck-slab forms were completed.

Gravel and sand was taken from the river bed near the bridge site. The mix was 1 cement to 4 parts of well graded gravel. The mixer was set upon the slab form so that the piers and abutments could be run by gravity discharge. As soon as one pier was poured the mixer was moved forward to the next. To pour the spans, the mixer was set in the center of each one, and the floor and girders were run at the same time, without moving the mixer until the next span was to be run. The two central spans were poured as a unit. Each span was run in an average of seven hours. The concrete was poured wet enough to run down a trough on a 1 to 7 slope.

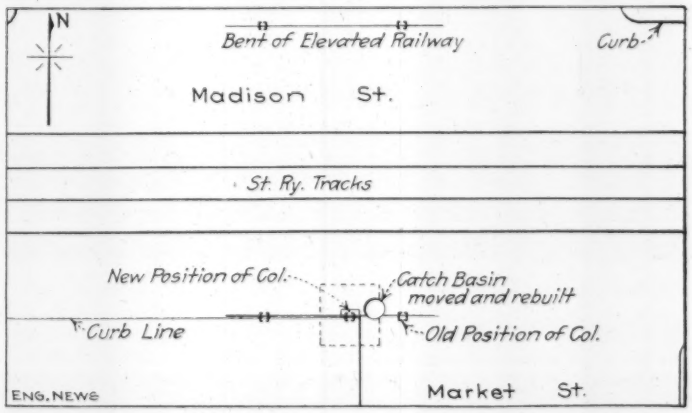


FIG. 1. PLAN SHOWING THE OLD AND NEW POSITIONS OF THE COLUMN OF AN ELEVATED RAILWAY WHICH WAS SHIFTED ON ACCOUNT OF BEING AN OBSTRUCTION IN THE STREET

The roadway was designed to carry a distributed live load of 200 lb. per sq.ft., or the concentrated loading of a 20-ton road roller. It contains 19½ tons of steel and 320 cu.yd. of concrete and cost $7439. A gang of 10 to 12 men completed the construction in 88 working days. The designer was George D. Dobson, of the Capital City Construction Co., of New Hampton, Iowa, which built the bridge, but the design was checked and approved by Thos. H. MacDonald, State Highway Engineer.

The concrete structure described replaced a 150-ft. steel bridge, the upper chords of which show above the new bridge in Fig. 2. The county supervisors at first proposed that the new bridge should be only 140 ft. long. This idea was abandoned when it was believed that owners of lowland farms, bordering on the river, would make claims for flood damage if the channel of the stream was narrowed by erecting a shorter bridge than the old one. So, to prevent possible lawsuits, based on the claim that flood water was diverted from its natural course by the shorter bridge, and inundated the land, another span was added and extended well out over the low south bank.

Shifting the Column of an Elevated Railway

The Chicago & Oak Park Elevated Ry., of Chicago, has a stub branch extending south on Market St. to the south side of Madison St., and consisting of two-column bents with transverse plate girders between which the longitudinal girders are framed. There is a considerable jog in the line of Market St. at this intersection, so that one of the columns in the end bent (on the south side of Madison St.) came at an awkward position in the roadway near the corner of the curb, forming an obstruction to traffic. The city's street department requested the removal of this column to the curb line, a distance of about 8 ft., and this has been done. Fig. 1 shows the general situation, with the old and new locations of the column. Fig. 2 shows the end-bent as reconstructed.

The column spacing is now 12 ft. 9 in. instead of 20 ft. 9 in., giving an overhang of 13 ft. for the east end of the girder. The end of the girder was supported by timber posts, with jack-screws and blocking, while the east

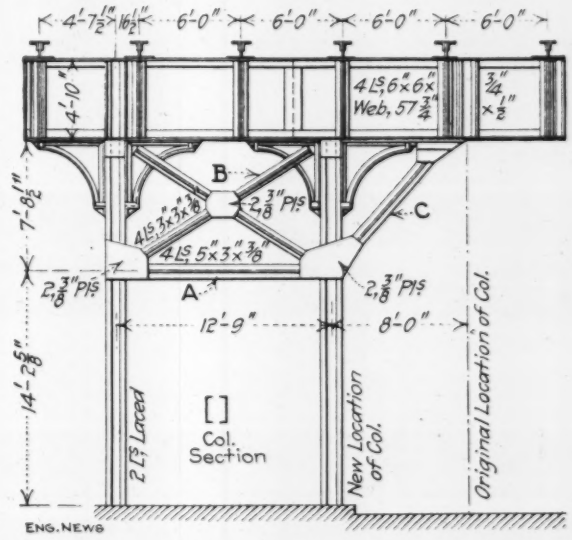


FIG. 2. RECONSTRUCTED BENT OF CHICAGO & OAK PARK ELEVATED RY. WITH ONE COLUMN SHIFTED TO REMOVE IT FROM THE ROADWAY

column was removed and shifted. The two columns were then connected by a horizontal brace *A* and the cross-frame *B*, the ends of the latter being riveted to the new connection-plates on the columns and to the kneebraces under the girder, as shown in Fig. 2. To support the overhanging end of the girder, the inclined strut *C* was applied. This arrangement theoretically puts a slight upward lift on the west column of the bent, but this is sufficiently anchored to its foundation to take care of any such uplift. The new column is anchored by four bolts 1¼x53 in., connected at the bottom by four flats 6x25½x⅜ in. These are embedded in the concrete pedestal, which extends about 11½ ft. below the sidewalk level. For drawings and information relating to this interesting and unusual piece of work we are indebted to C. M. Mock, Chief Engineer of the Chicago Elevated Rys. Co., which controls all the elevated railways of that city.

❖

The Hudson Bay Ry. is to have its southern terminal at Le Pas on the south side of the Saskatchewan River. Engineering and construction headquarters will be located here and sufficient machine and repair shops to care for the contractors' equipment while the line is under construction will be built the coming summer.

Sand-cement as Used by the U. S. Reclamation Service

It was noted in ENGINEERING NEWS, Jan. 16, 1913, p. 118, that the U. S. Reclamation Service is using in two of its large irrigation dams, the Elephant Butte and the Arrowrock, a sand-cement made up of an equally blended mixture of sand and portland cement ground together to a fineness approximating that of normal portland cement. This is so obviously an economy in the cost of cement that the behavior of such a mixture is of great interest to engineers who might consider its use in future work. Some notes on this behavior were given by Charles H. Paul, Construction Engineer on the Arrowrock Dam, in the February, 1913, *Proceedings* of the American Society of Civil Engineers, p. 271, as a discussion of J. B. Lippincott's previous paper on "Tufa Cement." The important parts of Mr. Paul's discussion are given below.

In the construction of the Arrowrock Dam—which is being built by the U. S. Reclamation Service to store the flood waters of the Boise River—about 550,000 cu.yd. of concrete will be laid, and the cost of cement is, of necessity, a most important item. The dam is about 22 miles above the City of Boise and 17 miles above Barberton, the nearest point on the Oregon Short Line R.R. A railroad from Barberton to Arrowrock has been built by the United States Government, over which the freight rate on cement charged against the work is 23c. per bbl. The commercial freight rate on cement from Utah mills to Barberton is $1.14 per bbl., from California points $2 per bbl., and from Kansas points $2.09 per bbl.; so that the total freight charges on cement to the Arrowrock work are from $1.37 to $2.32 per bbl.

Laboratory tests on sand-cement have been carried on by the Reclamation Service for 6 years or more, and, during the winter 1910-11, when the investigations in connection with the storage works on the Boise River were nearly finished, a series of these tests was started, using for blending material the native rocks in the vicinity of Arrowrock, particularly granite from the spillway site, a large quantity of which would have to be wasted during the construction period. Table I is an average of three long-time tensile tests of sand-cement mortars (1: 3, by weight, standard sand), each test being an average of 5 briquettes, compared with mortars made from portland cement used in the manufacture of the sand-cements and tested under the same conditions. The blending material for sand-cement was river sand or granite, blended in each case with equal parts by weight of portland cement.

TABLE I. LONG-TIME COMPARISON OF SAND-CEMENT AND PORTLAND CEMENT

[Tensile strength in lb. per sq.in.]

Kind of cement	7 days	28 days	3 mos.	6 mos.	1 year	2 years	3 years	5 years
Sand-cement....	219	333	397	423	457	423	449	444
Portland cement	266	400	425	482	460	496	428	404

TABLE II. TENSILE TESTS OF STANDARD 1:3 PORTLAND CEMENT MORTAR BRIQUETTES

[Lb. per sq.in.]

7 days	28 days	3 months	6 months	1 year	2 years	3 years	5 years
260	373	448	447	432	411	379	398

TABLE III.—SAND-CEMENT TESTS ON MATERIAL FROM ARROWROCK DAM SITE, ARROWROCK, IDAHO

Blending material, spillway granite. Mix, 1:3 by weight with standard sand. Lb. per sq.in.

Percentage of blending material	7 days	28 days	3 months	6 months	1 year
	Tensile Tests on Standard Briquettes				
0	343	428	461	467	408
30	374	417	467	499	494
40	368	467	504	...	...
50	330	419	460	452	410
60	294	369	400	...	...
70	156	237	266	320	335
	Compression tests on 2-in. cubes				
0	1077	1969	3720	3744	....
30	1631	2454	3171	4392	4656
50	1471	1763	2729	3121	3712
70	458	938	1215	1256	1560

Table II shows average long-time tensile tests on 13 brands of portland cements used by the U. S. Reclamation Service during the last five years. It is noticeable that there is not the marked decrease in strength in the case of the sand-cement briquettes as is shown here, and is so common with portland cements.

The first column of Table III (percentage of blending material) in each case represents the portland cement from which the sand-cement is made, tested under the same conditions.

Investigations of the actual use of sand-cement in structures which had been in service for 10 or 15 years, further tests in the local laboratory, and estimates of cost of installation and operation of the necessary equipment, finally led to the decision to use sand-cement, in so far as practicable, in the construction of the Arrowrock Dam, and to use for blending material granite from the spillway excavation.

A sand-cement plant, with a capacity of 1000 bbl. per 24 hrs., consisting of a crusher and sand rolls, rotary dryer, ball mill, mixing machine and three tube mills, all electrically operated, with the necessary bins, hoppers and conveying machinery, has been erected and has been in operation for about two months. The cost of this mill complete was about $46,000, itemized as follows:

Excavation	$1,500
Foundations	3,750
Erection of building, chutes, etc.	8,150
Equipment, including freight	23,000
Installation of equipment	7,850
Electrical work	1,750
	$46,000

The total output of the mill to date has been about 25,000 bbl., and about 20,000 cu.yd. of sand-cement concrete have been placed in the dam, up to the present time.

All incoming portland cement is tested and accepted before shipment. All sand-cement is tested for fineness, blend, setting time, and tensile strength in 1: 3 sand briquettes, and is subjected to the boiling test before being used in the work. Tests for fineness and blend are made every hour that the mill runs, or oftener if either needs correction, and the other tests are made on an average sample from each day's run. The blend now being used is 45% granite by weight, and the requirement for fineness is a least 90% passing a 200-mesh sieve. Standard portland cement requirements are satisfied by the other tests, and no sand-cement is used until it has passed the 7-day tensile tests of 200 lb. per sq.in. The writer's experience is that no sample tested has ever failed to pass the boiling test.

None of the sand-cement tested has failed to pass either the 7-day or the 28-day requirements. Occasionally, briquettes have been broken at the age of 4, 5, or 6 days, and in every case yet tested these briquettes have shown a strength exceeding 200 lb. per sq.in.

TABLE IV.—MILL-RUN TENSILE TESTS ON SAND-CEMENT MANUFACTURED AT ARROWROCK

All tests on 1:3 standard sand briquettes. Strength in lb. per sq.in.

Average of all (52) 7-day tests.... 258	Average of all (29) 28-day tests... 332
Average of 10 lowest 7-day breaks. 221	Average of 10 lowest 28-day breaks304
Average of 10 highest 7-day breaks 297	Average of 10 highest 28-day breaks..... 366

A representative cost of manufacturing 1 bbl. of 45% by weight blend of sand-cement at Arrowrock is given in Table V, which includes depreciation, on the plant and installation, at a rate which will wipe out the total cost at the time that a total output of 500,000 bbl. is reached. It does not include sacking, as most of the sand-cement will be used in bulk.

TABLE V.—COST OF MANUFACTURING SAND-CEMENT

Items	Unit cost of sand-cement per bbl.
Granite delivered to crushers	$0.92
*Portland cement, including freight and storing	1.35
Handling and storing portland cement	0.08
Labor, operating	0.10
Power and lights, including maintenance, etc.	0.16
Installation, depreciation, supplies, repairs, etc.	0.14
Total cost	$1.85

* Portland cement @ $2.36 per bbl., f.o.b., Arrowrock.

The use of sand-cement under actual working conditions brings out several characteristics that are different from those of portland cement.

Comparing sand-cement concrete with portland concrete, batch by batch, an experienced concrete man will note no difference, either in its appearance or in its behavior while being spread, but, after a run of an hour or two, in mass work, it will be noticed that an ordinary plastic or quaking

mixture gives off water more readily than does portland cement concrete, and that this water is clearer and apparently carries less cement than is the case with ordinary concrete.

A mushy or really wet mixture which is worked up continually shows, at the surface, an accumulation of sloppy material which is more marked than in portland cement and sets and hardens very slowly. In fact, it is the writer's opinion that, for this reason, extremely wet mixtures should be avoided, especially with sand-cement concrete.

Sand-cement concrete sets more slowly than ordinary portland-cement concrete, and its slowness in hardening is very marked. It is natural to asume that internal shrinkage stresses, due to setting and hardening, will be less on this account, but, at the present time, we have no other evidence on this point.

The writer has not noticed that sand-cement concrete adheres to the forms any more than portland concrete, and as he has had no occasion to use sand-cement plaster, he has not had an opportunity to compare it with ordinary cement plaster.

It is natural for the ordinary construction man to look on a new product with prejudice, especially when it shows characteristics to which he is not accustomed; but supposing, for the sake of comparison from another viewpoint, that sand-cement had been in general use for years and that portland cement were the new product being introduced; would we look with favor on a cement which almost invariably showed a decrease in strength after a few months? Or one which not infrequently failed to pass the boiling test? Would we consider it a favorable sign that the excess water coming to the surface of concrete apparently brought with it an unusual quantity of cement? Quick-setting cements are usually considered undesirable for use in mass work, and were we accustomed to the slow-setting and slow-hardening sand-cement, might we not look with suspicion on a quick-setting cement, especially if one of the quicker setting portlands happened to be the first of the new product to fall into our hands?

The use of sand-cement in mass work, where the requirements are enough to justify the installation of the necessary grinding machinery, where suitable blending material is available, and where the transportation charges on portland cement amount to a considerable portion of its cost laid down, will result in a marked saving in construction costs, and will give a product which is at least the equal of the portland cement from which it is made, in fact, one which, for ordinary requirements, is not open to the least suspicion.

❖

A Non-corrosive Iron Alloy*

A practically non-corrosive iron alloy has recently been put on the market under the trade name "duriron." This metal is the result of study at the plant of the Dayton Malleable Iron Co., under the lead of P. D. Schenck, president of the company. The alloy is quite resistant to ordinary rusting and is only slightly attacked by alkalies and acids, with certain few exceptions. As instances of these properties, the following data are arranged from tests which are still under way in the laboratory of Dr. C. F. McKenna, New York City:

Acid	Loss of Weight				
	Cast iron	Wrought iron	Monel metal	Tobin bronze	"Duriron"
Nitric	100% in 63 hr.	100% in 58 hr.	100% in 58 days	100% in 7.5 days	0.01% in 20 weeks
Sulphuric	100% in 16 days	100% in 30 days	1.58% in 26 weeks	0.43% in 16 weeks	none in 26 weeks
Hydrochloric	100% in 97 hr.	100% in 46 days	18.4% in 16 weeks	17.9% in 16 weeks	1-1.5% in 16 weeks

All specimens in these tests were approximately ¼x¾x3 in. in size. The acids were 25% monohydrate, used cold. It has been noted that this new alloy is more markedly attacked, however, by high concentrations of phosphoric acid, though not by more dilute solutions. It is reported that up to 50% monohydrate (50° B) there is no action, but at 85% it is decided. More complete data on the corrodability of this alloy are not yet available. Cyanide solutions have no appreciable action and the metal has proved entirely stable for use as dye-house tools, where "off color" of dyed material gives a delicate test for the entrance of metallic salts into the dye solutions.

"Duriron" closely resembles cast iron, but it is some 10% lighter in weight. It has shown an average ultimate strength of 70,000 lb. per square inch in compression, with 15,000 lb. tension; the elastic limit is very close to the ultimate strength, as the metal is somewhat more brittle than cast iron. It melts at 2250° F. and is a much better conductor of heat and electricity than cast iron. The actual composition of the metal is not announced, though the makers admit that some 10% or more of silicon is to be found. They claim also that an analysis of "duriron" specimens does not give a key to success in making up such an alloy, as certain processes and materials which are necessary are not disclosed by the final product. It is claimed that full control over the final composition has been obtained, so that the desired qualities are always assured.

The only way of working this alloy is by casting and grinding; as it is about one-half harder than cast iron, it cannot be machined by the older processes. The abrasive found most successful with it is carborundum. Shrinkage in casting is found to be about $\frac{3}{16}$ in. to a foot, compared with the ⅛ in. ordinarily assumed for cast iron. At first great difficulty was found in obtaining good castings on account of peculiarities of shrinkage, but many troubles have been removed by experience, though the foundry loss is still heavier than with ordinary iron castings. The pig alloy has to be remelted in a gas-fired cupola in order to prevent the entrance of foreign materials which rob the castings of the desired characteristics. It has been found that cupola practice is so important that "duriron" is not recommended to general foundrymen, although the makers will sell the alloy in pig form.

Up to the present, large plane surfaces have not been successfully cast, the principal trouble being in shrinkage cracks. This difficulty is removed by giving the surfaces a certain curvature, the minimum corresponding to a maximum radius of 8 ft. This works no inconvenience in comparatively small work and in the miscellaneous fittings for which the alloy has been reported particularly desirable.

While castings of this metal have been commercially available for less than a year, already a considerable demand has sprung up according to reports of the makers. The present use is mostly in acid pipe-line fittings, valves, cocks, receptacles, etc., in centrifugal pumps, steam siphons, and in substitutes for earthenware fittings of chemicals works, powder and celluloid factories.

Apparatus is made to order from this alloy by the Duriron Castings Co., of New York, with foundries at Dayton, Ohio.

❖

Government Ownership of Telegraph Lines was recommended by Postmaster-General Hitchcock in his last annual report, as follows:

In the last annual report the opinion was expressed that telegraph lines in the United States should be made a part of the postal system and operated in conjunction with the mail service. It is believed that under proper management such a consolidation would result in important economies and permit adoption of lower telegraph rates. Now that a postal savings system has been established and a parcel post provided for, there would seem to be no better opportunity for the profitable extension of our postal business than through the adoption of a government telegraph system.

*From information furnished by J. R. Pitman, Vice-President and General Manager of the Duriron Casting Co., 90 West St., New York City.

Report of the Alaska Railroad Commission

On Aug. 24, 1912, Congress passed an act authorizing the President to appoint a commission

> to conduct an examination into the transportation question in the Territory of Alaska, to examine railroad routes from the seaboard to the coal fields and to the interior and navigable waterways; to secure surveys and other information with respect to railroads, including cost of construction and operation; to obtain information in respect to the coal fields and their proximity to railroad routes; and to make report of the facts to Congress on or before the first day of December, 1912, or as soon thereafter as may be practicable, together with their conclusions and recommendations in respect to the best and most available routes for railroads in Alaska, which will develop the country and the resources therein for the use of the people of the United States.

Within a week after this date, President Taft had appointed to this Commission Major J. J. Morrow, Corps of Engineers, U. S. Army, as chairman; Alfred H. Brooks, geologist in charge of Division of Alaskan Mineral Resources of the U. S. Geological Survey, vice-chairman; Civil Engineer Leonard M. Cox, U. S. Navy, and C. M. Ingersoll, consulting railroad engineer, New York City. On Sept. 3 those members of the Commission resident in or about Washington left that city for Seattle. On Sept. 7 the whole Commission sailed for Alaska. From Sept. 7 to Nov. 17 the Commission spent its entire time traveling in and about Alaskan territory, examining topography, investigating proposed routes, and studying existing railways. This time was most strenuously occupied. For instance, on each of 25 successive days the entire Commission traveled some distance in either a buckboard, a wheel or sled stage, or an automobile, and on several of the days traveled over 35 miles, in one day covering 57 miles from 4 a. m. to 8 p. m. They returned to Seattle on Nov. 17, traveled through Canada to acquire what information they could of the northern Canadian railways, and reached Washington on Dec. 2.

On Jan. 20, 1913, their report was transmitted to the President. This report has just been published as "Document 1346 of the 62nd Congress, third session of the House of Representatives." It is a most exhaustive analysis of the resources and commercial requirements of that enormous territory of the Unifed States whose great value is just being realized. The report, a book of 172 pp., with maps, tables and diagrams, will bear study by anyone interested in the Alaskan territory. Space only will be taken here for a short description of the present railway facilities of Alaska and a reprint of the summary and recommendations of the Commission.

Resources of Alaska

The mineral wealth of Alaska is at present its most important resource, and the one which has brought about its present state of development. The developed mineral resources include gold lodes and placers, copper, tin and silver deposits, together with petroleum, marble and gypsum. There are also extensive fields of bituminous and lignitic coal and some iron ores, which are practically undeveloped. In addition to these, silver-lead, zinc, antimony, quicksilver, and other ores, and peat, graphite, asbestos and mica have been found. The most important mineral industry has been placer mining with gold lode mining a fair second. It may be said, however, that only the surface of Alaska has been scratched as far as mineral production is concerned, the more difficult methods of mining having been disregarded on account of the lack of transportation facilities.

Though public attention has for several years been focused on the coal deposits of Alaska, no coal mining has been carried on except that of its lignitic deposit for local use which was begun some 13 years ago. Large sums have been spent on surveys, development work, etc., in the Bering River and Matanuska fields. In spite of all this activity, the total output of coal in the territory up to the close of 1912 was insignificant, being less than 40,000 tons. During this period upwards of one million and a half tons have been imported into the territory. The main coal fields, as noted on the accompanying map, are the Bering River and Matanuska fields along the coast, and the Nenana field lying about 60 miles southwest of Fairbanks in the central portion of the territory. While the recent controversies regarding patent rights in these fields have served to retard their exploitation, the lack of railroad facilities has been equally responsible.

It is further stated by the Commission that there are large tracts of arable and grazing lands in central Alaska, for the most part unutilized because of the lack of transportation. These, too, should be opened by railroads.

Looking at the accompanying map it will be seen that the south coast is easily accessible by steamships and by the short railroads already built, but that the central area north of the Pacific Coast range, which area contains the bulk of the coal and mineral deposits and in which area is located the prosperous cities of Fairbanks, in the central portion, and Nome, in the western portion, is practically isolated except by means of wagon or sled traffic or in the summer by the river steamers. It is mainly to open this interior section that the construction of railways is recommended.

Present Transportation Routes

The total area of Alaska is nearly one-fifth that of the United States. About a quarter of this area lies north of the Endicott range, which is itself north of the Artic Circle. This portion of the territory is arctic and it alone presents the bleak and frozen aspect popularly associated with Alasks. South of this range in Alaska there is an area greater than all the space east of the Mississippi and north of the Ohio and Mason and Dixon's line, which is as capable of high development as many well traveled and rich countries. To the north of the Pacific mountain system, which parallels and is close to the southern coast of the territory, lie two rivers, the Yukon and the Kuskokwim, both of which pass through valleys with broad, open bottom-lands and gently rolling uplands. Both of these rivers, however, enter the Pacific Ocean at a latitude so far north as to be open to navigation only three or four months of the year. During those periods they are navigable far into the interior of the territory. There are other rivers entering the rich interior, notably the Copper River and Susitna River, both to the south, but these two rivers opening as they do into year-round harbors are more valuable for railway location than they are for river navigation. Steamboat service between the States and the southern portion of the territory is quite frequent, and during the summer months an equally frequent service is maintained to the north and west sides of the peninsula. The interior, where most of the mining, the principal industry of the peninsula, is carried on, is reached by river navigation

noted above, some wagon roads described later, and the following railroad lines (see accompanying map), built and operated by private companies:

Southeastern Alaska:	Mileage
White Pass and Yukon route, Skagway to White Pass (narrow gage). Terminal at White Horse, Yukon Territory—total mileage, 102 miles.	20.4
Yakutat Southern Railway, Yakutat to Situk River (narrow gage)	9.0
Copper River: Copper River & Northwestern Railway, Cordova to Kennicott (standard gage)	195.0
(The same company has built a few miles of track at Katalla, where the Alaska Pacific Railway & Terminal Co. has also done some work. At Valdez a few miles of track of the Alaska Home Railway were laid in 1907, and some work was previously done on the Copper River & Northwestern Railway and on the Valdez & Yukon Railway.)	
Kenai Peninsula: Alaska Northern Railway, Seward to a point near head of Turnagain Arm (standard gage)	71.6
Yukon Basin: Tanana Valley Railway, Fairbanks and Chena to Chatanika (narrow gage)	46.0
Seward Peninsula:	
Seward Peninsula Railway, Nome to Shelton (narrow gage)	80.0
Paystreak Branch, Seward Peninsula Railway (narrow gage)	6.5
Council City & Solomon River Railway, Council to Penelope Creek standard gage)	32.5
Wild Goose Railway, Council to Ophir Creek (narrow gage)	5.0
	466.0

Since 1905 the U. S. Government has maintained a Board of Road Commissioners in Alaska, and that commission has had constructed up to July 1, 1912, 829 miles of wagon road for use in winter and summer, 599 miles of winter sled roads, 1552 miles of trail, and in addition many miles of trail for winter travel only. According to the Railway Commission's report these roads, while not comparable with the best highway construction in the States, have shown remarkable return for the money expended. As is well known, the larger part of the travel in Alaska, especially in the winter months, has been carried on over these roads and trails. In its account of the transportation facilities now in Alaska, the Commission sums up as follows:

All Alaska has less than 500 miles of railway in nine disconnected systems, less than 1000 miles of wagon road, 600 miles of winter sled road, less than 2000 miles of trail, with 5000 miles of important navigable waterways, which are closed by ice for about three-quarters of the year and this in a country comparable in size, resources and climate to Norway and Sweden.

Summary

The main design of the Commission in its suggested routes has been to open up for industrial development the two great inland navigable water systems, the Yukon and the Kuskokwim, and to lay out the railways that these regions may be brought into communication with one or more ocean ports ice-free the year round. The other sections of the country should also be developed in the opinion of the Commission, but the main and primary effort should be the two named.

The summary of the Commission's report is as follows:

The data presented show that the United States possesses in Alaska a frontier territory of great size and of wonderful industrial possibilities. The Commission believes that its climate is favorable to permanent settlement and to agriculture; that its mineral resources are vast and as yet but little exploited; that its population is sparse, but only by reason of its inadequate transportation facilities; and that its people are of the same type of hardy pioneers that have carried the United States frontier to its present limits.

In arriving at conclusions and formulating findings the Commission has had in mind the terms of the act of Congress constituting its precept, which, briefly stated, provides for recommendations in respect to the best and most feasible railroad routes in Alaska from the seaboard to the coal fields and to the interior navigable waterways "which will best develop the country and resources thereof for the use of the people of the United States." It interprets this precept to mean recommendations:

1. For a railway or railways which give promise of affording the lowest transportation cost to tidewater of coal from one or both of the two best coal fields.

2. The projection of railways along such route or routes as would open the interior to commerce and colonization; the selection of such route or routes to be made after giving due weight to lowest cost, and shortest time of construction, maximum economy of operation, and service to the largest areas of known natural wealth, best adapted to permanent colonization; and, finally

3. That these proposed railways must be based on the best ocean terminals.

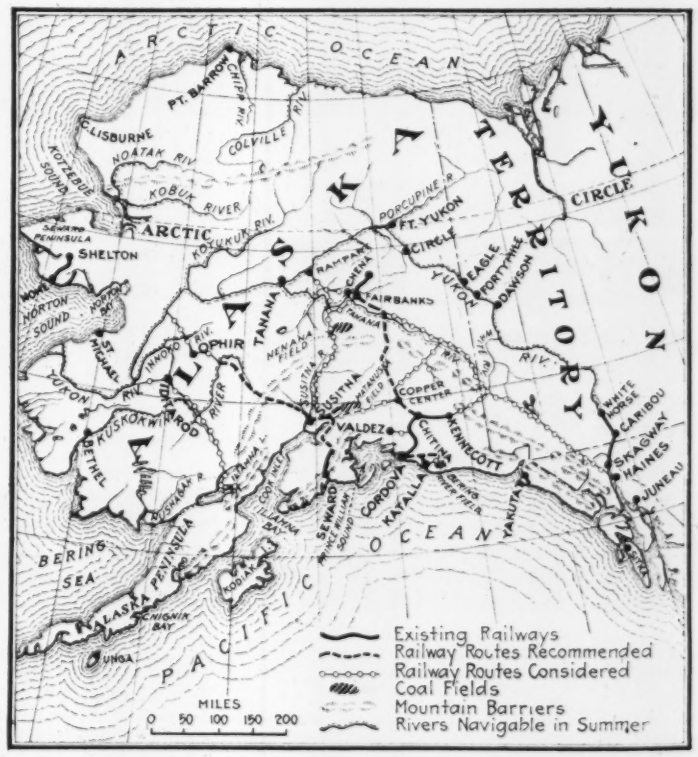
The routes considered by the Commission fall into three classes:

(1) Those which reach the interior, but do not give economical access to either of the two principal coal fields. In this class are: The Skagway route; the Haines-Fairbanks route; the Iliamna-Kuskokwim route; the Valdez-Fairbanks route.

(2) Routes which reach the coal fields only. In this class fall the routes from Katalla and Controller Bay.

(3) The routes which reach the interior and at the same time will furnish economical transportation for the two coal fields. In this class are the Cordova-Fairbanks route; the Seward-Fairbanks route; the Seward-Innoko-Iditarod route. These routes will be considered in the order above presented.

For convenience in discussing the relative merits of the various routes under consideration, it has been deemed expedient to arrange the physical and economic characteristics of each in such form as to facilitate comparison. Accordingly, two tables have been prepared and are here inserted. Table I shows the various features of the six through or trunk routes, while Table II refers to the proposed coal roads. The headings of the different columns are descriptive of the data furnished and therefore require no further explanation.



Map of Alaska, Showing Present Railways and Railways Proposed by the Alaska Railway Commission

Of the routes that do not reach either of the principal coal fields, two have their coastal terminals in southeastern Alaska, namely, at Skagway and at Haines-Pyramid Harbor. These two routes have much in common, but as between the two harbors, the location at Haines, with its possibilities of development on both sides of the peninsula, and with its good anchorage area, possesses advantages over Skagway.

The Commission believes that a railroad will be built at an early date, connecting Haines with the Canadian interior, for the development of local resources, and that the development of central Alaska and adjacent portions of Canada will ultimately call for an extension of this line into the Tanana Valley and possibly on to the Seward Peninsula. The route presents many attractive features; but in common with the route based on Skagway, the mileage to Fairbanks is excessive, is partly in foreign territory, and as yet no high-grade coal has been discovered which can be conveniently served by either of these routes. The Commission therefore feels justified in confining its further considerations to the routes reaching the interior from ports on the Gulf of Alaska west of the one hundred and forty-first meridian.

The third route, which does not give access to either of the principal coal fields, is the route from one of the harbors on Cook Inlet into the valley of the Kuskokwim. These harbors may be passed over the statement that no railroads can be based on any of them that will assist in the development of the Territory as efficiently or as economically as can be done by lines reaching the coast farther north and east. They lie too far southwest to develop conveniently the known resources of the interior. The Commission, however, desires to state that Iliamna Bay or Iniskin Bay has possibilities for use as a terminal for a short line intended to develop the resources and industries of the immediately tributary region. This eliminates all routes to the interior that will not economically serve either of the two principal coal fields, excepting the route from Valdez.

Valdez has a harbor inferior only to that of Cordova and about equal to that of Seward. There is no probability, however, of its being utilized as an outlet for either Bering River or Matanuska coal. The commission considered the possibilities of developing Matanuska coal by way of this port; but the haul involves the surmounting of two major summits (Tahneta and Thompson Passes) and one minor summit (Ernestine), besides being longer in distance than the haul over the alternate route to Seward. It is not surprising, therefore, that operating costs are shown to be excessive. With industrial advancement it is probable that Valdez will require the construction of one or the other of the lines connecting it with the Copper River Valley. The Thompson Pass route would also have value in case equitable trackage arrangements for traffic through to tidewater cannot be effected by the proposed Chitina-Fairbanks road.

This leaves for consideration the routes giving economical access to the two coal fields. Before discussing these routes which are affected by the development of these fields it is desirable to briefly consider the coal question.

In the absence of information to the contrary the Commission assumes that the coal deposits of the Bering River and Matanuska fields are on a parity as to quality of product and cost of mining. The heart of the Bering field lies about 30 miles from the coast at either Katalla or Controller Bay, about 76 miles from Cordova, and about 38 miles from the existing tracks of the Copper River & Northwestern Ry. The heart of the Matanuska field is 187 miles from Seward, 115 miles from the present northern terminus of the Alaska Northern Ry. Both fields are reported to contain bituminous coal of good coking and steaming quality, in composition approximating the best coals of the eastern fields in the United States, but both are so folded and crushed as to add to the expense of mining and to much reduce the percentage of lump in the output.

It has been shown by analyses of operation costs that these coals can probably be delivered at their respective terminal points for the following figures per ton. These figures are based on an assumed output of about 500,000 tons annually, and include only transportation and terminal costs.

Estimate of cost of transporting and loading coal:

	Per ton
Bering River coal to—	
Katalla	$0.97
Controller Bay	0.89
Cordova via Lake Charlotte	1.44
Matanuska coal to Seward	3.38

It has been shown that Alaska coal could probably compete with other coals in the west coast markets, provided that the operators both of the mines and of the transportation lines are content with reasonable profits.

Controller Bay and Katalla each require for terminal development a first cost of construction that will assuredly be high and will certainly require high maintenance charges. Moreover, the completion of such terminal would offer harbor facilities very inferior to those that can, at little expense and at low maintenance charge, be had at Cordova. While the costs of transportation to these points are lower than that to Cordova, the Commission believes that it would be unwise to attempt harbor construction at either Katalla or Controller Bay at present. An additional and important reason for this decision lies in the fact that if either of these places were developed as a coal-shipping port all Bering River coal used in Alaska would have to be transshipped unless a line from Katalla to a junction with the Copper River Ry. were built. It is evident that such a railway would serve, for the present at least, to make harbor construction at either Katalla or Controller Bay superfluous, for it would at once give the coal an outlet to tidewater at Cordova, as well as inland by the Copper River Valley.

The Commission is of opinion that the routes based on Skagway, Haines, Iliamna Bay and Valdez are eliminated for the lack of high-grade coal, and those based on Katalla and Controller Bay by the present unsuitable harbor facilities, which would be remedied only by difficult and costly construction. This reduces the discussion to the three routes which penetrate inland Alaska and at the same time give convenient access to the two coal fields. Two of these routes reach the heart of the Tanana Valley, one from Cordova and one from Seward. The third reaches the Kuskokwim from Seward. The two routes into the Tanana will first be compared.

After its study of all available harbors, the Commission is of the opinion that the one at Cordova is, without question, the best. It has no disadvantage not possessed by all and one great advantage possessed by no other, namely, an ample area of good anchorage. Seward is evidently the seaport for the Matanuska coal and Cordova the logical outlet for the Bering River coal. The comparisons of transportation rates given in the foregoing table show that for an output of 500,000 tons annually it will cost $1.96 a ton more to haul Matanuska coal to Seward than it will to haul the Bering River coal to Cordova, and the analysis further shows that for double this output the additional cost will be $1.11. This places the Matanuska coal at such disadvantage that it could probably not be marketed at tidewater in competition with the Bering River coal.

To now consider the trunk lines to Fairbanks over their two routes: For the purpose of comparison a digest of the analyses of mileage and cost of new construction, mileage between terminals, and freight rates on these two lines is here again presented.

Terminals	Distance	New mileage	Cost of new construction	Average freight per ton Estimate 2*	Average freight per ton Estimate 3†
Cordova-Fairbanks	445	313	$13,971,000	$36.94	$24.43
Seward-Fairbanks	463	391	17,708,000	40.20	27.71

*Based on passenger-mile tariff of 7c. and freight-ton-mile tariff of 9.13c. and private construction, requiring 6% of first cost as fixed charges.

†Based on passenger-mile tariff of 6c. and freight-ton-mile tariff of 6.04c. and government construction or aid, reducing the fixed charges to 3% of first cost and omitting a $100 per mile license tax.

TABLE I—COMPARISON OF TRUNK LINES

Name of route	New track mileage	Existing track mileage	Total cost of new construction	Average construction cost per mile	Maximum grade North bound Per ct.	Maximum grade South bound Per ct.
Haines-Fairbanks	638	...	$28,186,000	$44,300	2	2
Cordova-Fairbanks	313	132	13,971,000	44,600	1.13	1.51
Valdez-Fairbanks	330	...	18,545,000	48,800	3	3
Seward-Fairbanks	391	72	17,708,000	45,000	2.3	2.2
Seward-Iditarod	344	72	17,970,000	52,300	2	2
Iliamna-Kuskokwim	400	...	22,199,000	55,400		

Name of route	Number of summits	Total lift north bound Feet	Average freight rate per ton-mile Cents	Average rate per passenger-mile Cents	Through freight rate per ton	Through passenger rate
Haines-Fairbanks	2	4000				
Cordova-Fairbanks	1	4260	8.30	7	$36.94	$31.15
			5.49	6	24.43	26.70
Valdez-Fairbanks	3	5970	9.13	7	34.69	26.60
			6.04	6	22.95	22.80
Seward-Fairbanks	3	4900	8.55	7	40.20	32.90
			5.68	6	26.71	28.20
Seward-Iditarod			16.5	10	68.64	41.60
			11.63	6	48.38	33.28
Iliamna-Kuskokwim	..	....	.....	..	.....	.....

Cost of new construction contains equipment and overhead charges.

TABLE II.—COMPARISON OF COAL LINES

(Freight rate is calculated for 1500 tons daily output at mines.)

Name of route	New track mileage	Existing track mileage	Total cost of new construction	Average construction cost per mile
Bering River-Katalla-Cordova	55	38	$2,700,000	$49,000
Bering River, Lake Charlotte, Cordova	38	38	2,054,000	54,900
Bering River, Katalla Bay	31	...	[1]1,702,000	55,000
Bering River, Controller Bay	25	...	[1]1,430,000	57,000
Matanuska, Chitina, Cordova	163	132	8,434,000	51,700
Matanuska, Kern Creek, Seward	115	72	4,945,000	43,000
Matanuska, Valdez	230	...	12,662,000	55,000

Name of route	Maximum grade North bound Percent.	Maximum grade South bound Percent.	Number of summits	Total lift south bound Feet	Average freight rate per ton-mile Cents	Through freight rate, mines to terminal	Through freight rate, mines to ship
Bering River, Katalla, Cordova	1.3	0.58	...	145	1.39	$1.29	$1.54
Bering River, Lake Charlotte, Cordova	1.3	1.7	1	360	1.51	1.17	1.42
Bering River, Katalla Bay	1.3	0.58	...	145	2.50	.77	.97
Bering River, Controller Bay	1.3	0.58	...	145	2.79	.69	.89
Matanuska, Chitina, Cordova	1.13	2.2	1	2180	1.66	4.90	5.15
Matanuska, Kern Creek, Seward	2.3	2.2	2	1750	1.36	3.13	3.38
Matanuska, Valdez	3	3	3	3980	1.70	3.91	4.16

[1] Exclusive of terminal, which is estimated at $2,500,000.

Cost of new construction contains equipment and overhead charges.

It is evident that, on the Cordova route, the first investment will be less than on the Seward route; the resulting freight rates will be lower; the terminal port offers a better harbor than the one at Seward; and the tributary coal field promises the earlier development because its product can be marketed cheaper. Each of these economic features points clearly to the advisability of reaching the Tanana Valley via the valley of the Copper River, and the Commission therefore recommends the construction of a railway from Chitina to Fairbanks.

The construction of a railway through the Copper River Valley to the Tanana would leave a large and very important part of Alaska unprovided for. It would in no way furnish transportation facilities to the rich agricultural lands and mineral wealth of the lower Susitna or make available the coals of the Matanuska fields. While this coal is probably barred for the present from tidewater competition with the Bering River coal, it yet has great value for local use. Moreover, and still more important, a railway to Fairbanks from Cordova will not serve the great Kuskokwim Valley, and therefore not fulfill all the demands for rail connection with inland navigable waters. Fortunately both the Kuskokwim and Susitna Valleys can be developed by a railway from Seward to navigable waters on the Kuskokwim.

The building of this line into the Susitna Valley is second in importance only to a line to Fairbanks, and its extension into the Kuskokwim should also be provided for as soon as possible, and the Commission so recommends.

The Commission believes that the two railway lines into which this discussion has resolved itself will form two systems that will at once advance development in the Territory. This recommendation for two trunk lines connecting navigable waters is in accord with the natural evolution of railway construction. In new countries the first lines of communication established are always those built over the main divides and connecting with navigable waters, and thus serving to supplement water transportation. It is only in well-settled countries that lines tying together such transverse systems and paralleling waterways are built.

The industrial advancement which will follow the building of the main trunk lines cannot fail to call for the extension of many branches to serve adjacent districts. There is no reason to believe that such branches will not follow in Alaska as they have in all railroad history, and such extensions will ultimately provide for intercommunication between the two systems here recommended. Several such extension lines have been mentioned in this report. Those most important, in the opinion of the Commission, are the coal branches; the extensions from Fairbanks to the Yukon River, so that the scope of rail service may reach the main Yukon Valley; the extension from the Chitina-Fairbanks line to reach the Nebesna Valley; and one at least of the two routes connecting Valdez with the Copper River Valley. In the opinion of the Commission the two coal branches should be built at once; the others will follow the demand created by industrial development.

The Commission therefore recommend the construction of railway lines as follows:

1. Chitina to Fairbanks, 313 miles	$31,971,000
2. Bering River coal branch, via Lake Charlotte, 38 miles	2,054,000
3. Kern Creek to Susitna Valley, 115 miles	5,209,500
4. Matanuska coal branch, 38 miles	1,616,000
5. Susitna Valley to Kuskokwim, 229 miles	12,760,500

In conclusion, it should be stated that the Commission is unanimously of opinion that this developmnt should be undertaken at once and prosecuted with vigor; that it cannot be accomplished without providing the railroads herein recommended under some system which will insure low transportation charges and the consequent rapid settlement of this new land and the utilization of its great resources.

Prospective Ownership of Railways

In regard to the possible ownership of these projected railways the report of the Commission contains the following statement:

Its instructions from Congress do not contemplate that any recommendation should be made as to how railroads in Alaska should be constructed, i.e., by private corporate ownership or by one of the many forms in use whereby government assistance is rendered. The Commission disavows any intention of making such recommendations, believing that Congress, in its wisdom, desired to reserve to itself the solution of that problem; but it has been impossible to form any estimates of costs of operation without some assumption as to the interest rate on the capital required for construction. This interest rate would obviously differ in two cases—construction by Government or bond guaranty, and construction by private capital. Moreover, were construction carried on by private capital unassisted, the necessity of earning sufficient income to pay operating expenses and interest on bonded indebtedness might make it the duty of the directors of the corporation to impose rates on traffic that would seriously retard the development which the Territory so greatly needs.

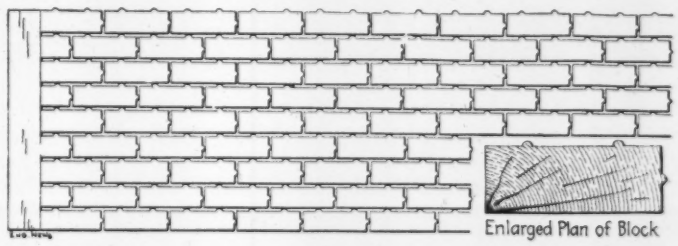
The Commission has therefore been forced to base its studies upon two hypotheses, viz.: That the capital necessary for construction is obtained at 6% interest, assumed as possible if construction is carried out by private corporate ownership unassisted; and that capital is obtained at 3% interest, assumed as possible if the construction is done either by the Government itself or by private capital with bonded indebtedness guaranteed both as to principal and interest.

In submitting the report to Congress Pres. Taft said in regard to this ownership question:

The necessary inference from the entire report is that in the judgment of the Commission its recommendations can certainly be carried out only if the government builds or guarantees the construction cost of the railroads recommended. If the government is to guarantee the principal and interest of the construction bonds, it seems clear that it should own the roads, the cost of which it really pays. This is true whether the government itself should operate the roads or should provide for their operation by lease or operating agreements. I am very much opposed to government operation, but I believe that government ownership with private operation under lease is the proper solution of the difficulties here presented.

Wood Paving with Lug-blocks

A special form of creosoted wood-block paving now in use to some extent has lugs formed on the sides and ends of the blocks, and three advantages are claimed for this construction: 1, with a compressible filler for the joints, the lugs provide for expansion of the blocks, and so prevent buckling or heaving of the pavement; 2, the open joints give a better foothold for horses than a wood-block pavement laid with close joints; 3, the blocks must necessarily be laid in proper position, as they cannot be laid on the side (or with grain horizontal).



Lug-blocks for Creosoted Wood Paving

The arrangement of the blocks in the pavement is shown in the accompanying cut. The lugs are formed by cutting beads on the planks as they go through the planer at the mill, the planks being then run through gang saws and cut up into blocks in the usual way. The blocks are made from Southern yellow pine, tamarack, beech or maple, and are of the ordinary sizes for wood-paving blocks.

At Toledo, Ohio, this paving is used on a part of Jackson Ave., where there is a grade of about 3%. We are informed that during recent sleety weather, when the streets were covered with ice, teams had no difficulty in ascending the hill paved with the lug-blocks. These blocks are the invention of H. G. Jennison, of the Jennison-Wright Co., Toledo, Ohio, which has been manufacturing them for about two years. The company states, however, that they may be made by any creosoting firm.

FIELD AND OFFICE

Clearing Up Steel Wreckage at Low Cost

A storage and shop building of the Carnegie Steel Co., at Bush and Wicomico Sts., Baltimore, Md., was burned Jan. 2, 1913. The steel frame of the building was converted into a tangle, lying on the stock piles; the latter and the machinery apparently were not much damaged. The wreckage was cut apart by oxyacetylene torch (see

Oxyacetylene Cutting in Wreckage of Steel-frame Warehouse, Baltimore, Md.

view herewith). A truck-mounted equipment (No. 3-T) of the Alexander Milburn Co., Baltimore, was used, with 50-ft. hose. A single torch, served by one operator with a helper, cut up the steel into lengths small enough to handle, faster than a gang of five men could load and take away the pieces.

The building was 130x300 ft. in plan. The cutting-up job took 10 nine-hour days, with some delay, or a net time of about 9 days (2 men with torch). G. C. Willett, Secretary of the Alexander Milburn Co., says that the cutting was done at a cost of about $10 per day.

❖

Concrete Sewer-pipe Tests in Kansas City

By E. S. Wallace*

Briefly, the tests required by Kansas City, Mo., in accepting concrete sewer pipe are:

Hydrostatic—Untreated pipe shall show no percolation up to 10 lb. pressure, and shall resist fracture at 33 lb. per sq.in. pressure.

Crushing Test—When supported on a bed of sand, so that an even bearing is provided throughout the length of the pipe, the various sizes of pipe shall withstand the following pressures, applied at the crown uniformly along a line 1 in. in width and extending the whole length of the pipe exclusive of the bell:

6 to 8 in.	1000 lb. per lin.ft.
9 in.	1050 lb. per lin.ft.
10 in.	1100 lb. per lin.ft.
12 in.	1150 lb. per lin.ft.
15 in.	1300 lb. per lin.ft.
18 in.	1450 lb. per lin.ft.
21 in.	1700 lb. per lin.ft.
24 in.	2000 lb. per lin.ft.

In recent specifications a clause has been inserted requiring clay pipe to pass the same tests as concrete pipe.

The first hydrostatic tests were made early in 1912, under the supervision of L. R. Ash, City Engineer. No arrangements had then been made for crushing tests. The left half of Fig. 1 will show the method. The bevel plate acted as a wedge against the slope of the bell, and when ruptures occurred we were unable to determine whther they were caused by water pressure, or by stress exerted by the plate. Also the leakage around the clamp bolts was such as to make percolation tests impossible.

The right half of Fig. 1 shows an improved design, with bolts outside. While far from satisfactory, this apparatus was a decided improvement, and we secured some very good tests. Almost without exception, fractures started at the bell, indicating that they were caused by wedge action of the bevel plate, so that our negative tests were unreliable.

Mr. Ash suggested the use of rubber-cup gaskets, and ordered a set made for 15-in. pipe. These were made 15 in. diameter on the bottom and flared to 15¼ in at the top of rim, and 1½ in. deep. Tests with these gaskets were made Oct. 12, 1912. The pipe was set on the baseplate, bell down, over a wooden core 3½ in. thick by 14½ in. in diameter, and the bottom gasket forced down inside until it rested on this core. The top gasket was secured to a cover-plate by a locknut on a nipple in the center of the plate through which water pressure was applied. As the gaskets were inside of the pipe, it was only necessary to draw the clamp-bolts tight enough to hold the plates in position. The pipe now received full

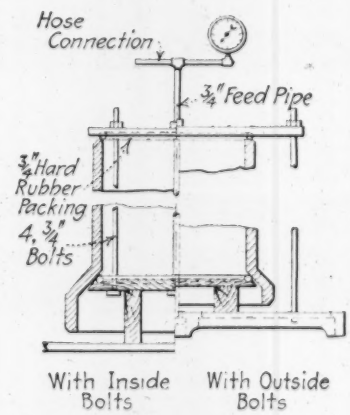


Fig. 1. First Device

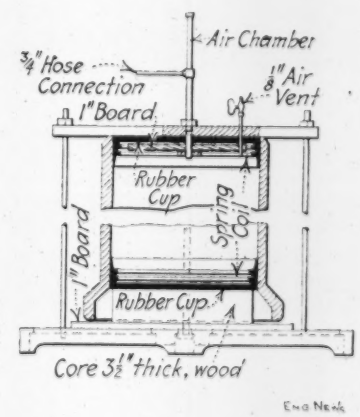


Fig. 2. Final Device

Hydrostatic Tests of Sewer Pipe

water-pressure, without undue stresses caused by drawing of bolts, etc., but as the gaskets were shallow and poorly

*Cement Inspector, Office of City Chemist, Kansas City, Mo.

made the excessive leakage made percolation tests impossible, though no difficulty was experienced in making internal-pressure tests. The pipe thus tested fractured longitudinally from the spigot end, confirming the theory that in former tests made with the old apparatus the ruptures were caused by wedge action of the bevel-plate.

Satisfied that we were on the right track toward a solution of hydrostatic tests, three sets of gaskets were made for 18-in., 21-in. and 24-in. pipe, 3 in. deep and made

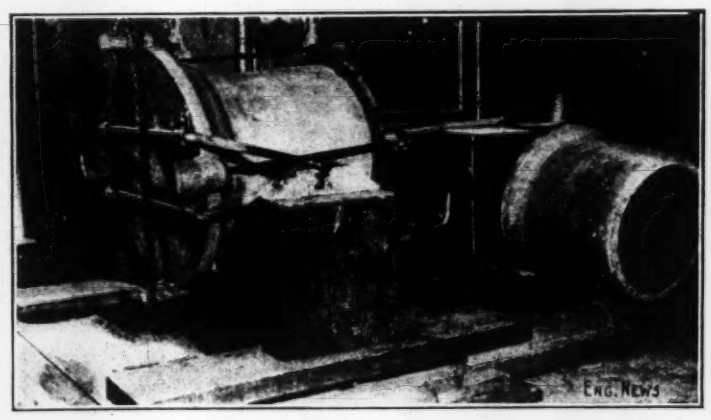


FIG. 3. KANSAS CITY SEWER-PIPE-TESTING APPARATUS WITH TILTING CRADLE
(24-in. pipe in position for testing.)

from the best motor-tire rubber obtainable. With these new cups, tests were made on 21-in. pipe. Brass spring-wire coils were placed inside of each gasket, which exerted enough pressure to hold the rim firmly against the side of the pipe (see Fig. 2). The bottom gasket was pressed down inside until it rested on a wooden core in the bell, the spring was drawn into a small coil and released inside of the gasket, the other spring was suspended inside of the top gasket, and the latter secured to the top plate and placed in position. As yet there was enough leakage around the top gasket, due to inaccuracy of the pipe surface, to make accurate percolation tests impossible, but on tipping the apparatus over until the pipe stood at an angle of about 15° from the floor, the little water that leaked through flowed along the ends of the pipe, leaving the body dry.

The tests were now so satisfactory that a cradle was ordered which could carry the whole apparatus on trunnions, as shown in Fig. 3. This makes it possible to place the pipe in position and, after drawing the bolts tight enough to hold it securely, fill it with water, and tilt it on its side for testing.

This apparatus is served by a 1000-lb. differential-hoist trolley running on a 5-in. I-beam suspended from the floor above. The water for testing is received through a ¾-in. 4-ply garden hose about 5 ft. long, connected to the main water line which supplies the building; a ¾-in. globe valve is used for filling the pipe, after which it is shut off and a ½-in. needle valve on a bypass is used to make the tests, as with this arrangement the pressure can be regulated evenly and water-hammer avoided. A specially designed water-pressure gage, with 12-in. dial, graduated to 1-lb. readings up to 200 lb., is used; this stands directly in front of the operator during the tests.

The above-described apparatus was designed by the writer, under the direction of L. R. Ash, City Engineer, and Dr. W. M. Cross, City Chemist.

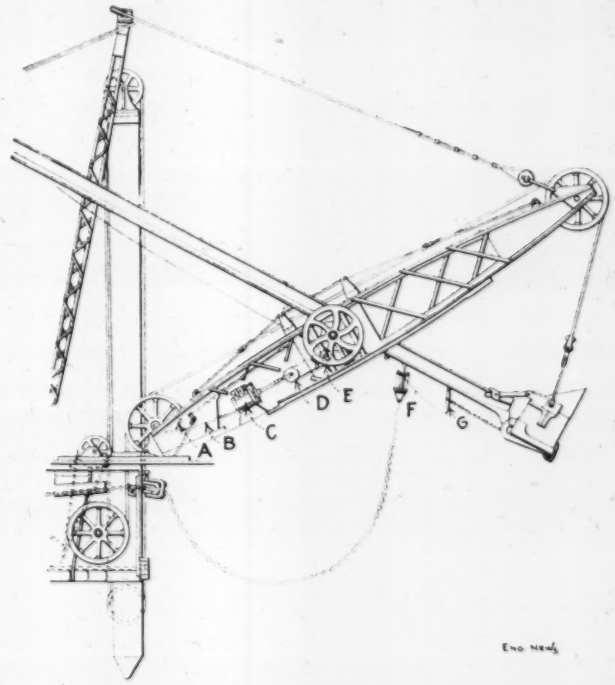
Quick-acting Steam-operated Trip for Dredge Dippers; Panama Canal

In the June 15, 1911, and Jan. 25, 1912, issues of ENGINEERING NEWS there appeared descriptions of several forms of dipper-tripping mechanisms in use on the Panama Canal dredges. One of the types described in the latter article consisted of a steam cylinder and plunger arrangement for use on a short-arm dredge. Of particular interest in the same connection is an article appearing in the Dec. 18, 1912, issue of the *Canal Record*, describing a similar steam-operated trip now in use on the dredges "Mindi" and "Chagres," which are operating in the Atlantic entrance channel in coral-rock excavation for the new piers of the Panama R.R. Co., at Cristobal. An abstract of the article is printed below.

This trip was devised to overcome the additional complications of tripping a long-arm dredge dipper. The device described was improvised by one of the cranemen from pieces of scrapped machinery.

The dredges, mounting 5-yard dippers, are used entirely in rock, which when necessary, has been partly broken up by the operations of the drillboat "Terrier." They are cutting channels of a minimum depth of 42 feet at mean tide, and this requires dipper handles of the great length of 62 feet, while the boom supporting the shipper shaft is 50 feet long. Because of the momentum of the heavy booms and dipper, the bucket is discharged on the swing, into hopper barges moored alongside the site of excavation.

This requires a quick-acting trip, to avoid spilling over the edge of the barge on the return swing. Operation by hand was slow and uncertain, because of the weight and accumulated slack in so long a trip line, and required the use of both hands by the craneman. It was necessary that a tripping device be both positive in action and simple in construction, because of the arrangement of boom and dipper stick. The device had to be so arranged that the tripping line would not have to be overhauled, on a drum or otherwise.



QUICK-ACTING DIPPER TRIP USED IN DEEP DREDGING AT CRISTOBAL, C. Z.

It will be seen by the accompanying sketch that the Cartier device consists of a steam ram C, mounted on a foundation in an out-of-the-way position on the interior of the boom. The steam exhausted from the operation of the ram is discharged below the surface of the water, in order that it may not obstruct the operator's view.

The cylinder is 5-inch bore and has a stroke of 8¼ inches. The piston rod carries the equalizing sheave, D, and the jamb movement of the ram piston is decreased by allowing the shock to be taken up in two heavy ½-inch by ½-inch springs 3½ inches long, mounted on the supporting guide arms for the equalizing sheave. The cylinder valve is of simple design and operated through the operating lever A and the reach rod B.

The latch chain is led to the purchase lever G, which is made fast to the dipper handle in the manner shown, and

a ½-inch flexible steel cable F, is made fast to the opposite end and led back over the small idler to keep the slack of the line from becoming entangled. It is then led over one of the two idler sheaves E, mounted on a stationary shaft parallel to each other, thence over the sheave D, back over the other idler sheave E, and up and dead-ended at the top end of the dipper handle. The 8¼-inch movement of the ram piston takes up 16½ inches out of the line to overcome the necessary operating slack and pulls on the latch, this being sufficient to secure positive action. The line's being attached as shown overcomes the necessity of winding in and out the otherwise free end upon a drum, this line being free to travel with the dipper handle over the idler sheaves E and the equalizing sheave D.

The closing of the door is accomplished by its flat surface striking the water with such force that it not only closes, but takes up the slack in the tripping line F and pulls the piston to a starting position in the ram.

The saving in time and the increase in yardage through use of this device cannot be arrived at, as no efficiency tests have been made. It is known, however ,that a considerable increase in the yardage has been achieved.

❖

Some Short-cuts in Reinforced-concrete Beam Design

By M. J. Lorente*

The writer has found the following methods of great convenience in the design of reinforced-concrete beams. As far as he knows they have not been published before.

Beam Weight Determination.

In designing reinforced-concrete beams, especially when the load and the span are large, the weight of the beam itself is a factor which considerably influences the depth of the beam. The general method of determining beam weight is of the "hit and miss" variety. It consists first in assuming a certain weight, for which the bending moment and consequent depth is computed. This is compared with the depth (computed from the weight) assumed, and the process continued until agreement is reached. This method depends altogether for its accuracy on the experience of the designer. If he be an expert he may guess the weight pretty accurately and he will need to use the bending moment formula only twice. If he be not an expert he will very likely have to guess several times before he arrives at the proper depth. But even experts, owing to the large range of widths for a beam, will find it rather difficult to gage the weight within, say, 20 lb. per ft.

In order to do away with this guessing process, the writer has evolved three formulas which, used in connection with the accompanying curve (Fig. 1), will give with almost perfect accuracy the weight of a rectangular beam.

The formulas are:

$$W' = (c + 0.003\,L)\,\frac{WL}{100}, \text{ when B.M. } = \frac{WL^2}{8}$$

$$W' = (c - 0.09 + 0.003\,L)\,\frac{WL}{100}, \text{ when B.M. } = \frac{WL^2}{10}$$

$$W' = (c - 0.17 + 0.003\,L)\,\frac{WL}{100}, \text{ when B.M. } = \frac{WL^2}{12}$$

Where:

W' = Weight of beam in lb. per ft.
W = Live-load on beam in lb. per ft.
L = Clear span in ft.
c = Reading from the curve (Fig. 1.)

It should be observed that the ordinates of the curve are obtained by, first, ascertaining the load carried by the beam per foot of span, and then dividing this load by the width of the beam, in inches, so that we have the load carried by the beam per foot length per inch width.

*Civil Engineer, 11 Everett St., Lynn, Mass.

When extreme accuracy is not imperative, the above formulas may be used to find the depth of the beam by substituting d (the depth) for W', and w (i. e., the weight carried by the beam per foot length per inch width) for W. It will be found that the results obtained from the curve only err, when they do err, very slightly and always conservatively, so that for purposes of estimating it will be very convenient to obtain the depth directly from the curve. For purposes of design the

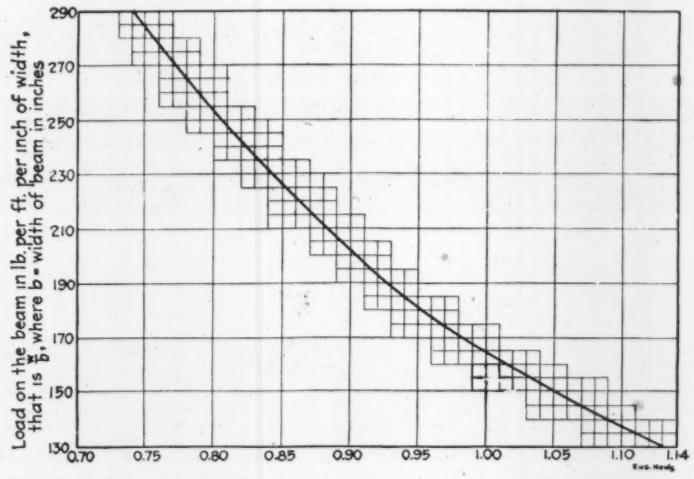


Fig. 1. Curve for Finding Weight of a Rectangular Reinforced-concrete Beam
[See text for explanation]

depth so obtained should be checked with the bending moment formula.

To illustrate the uses of the curve, let us take a particular example. Let us consider a beam 24 in. wide, with a clear span of 25 ft. and carrying a load of 5000 lb. per ft.

The load per ft. length per inch width will be:

$$\frac{5000}{24} = 209 \text{ lb.}$$

From the curve we obtain $c = 0.885$.

If we take the B. M. $= \frac{WL^2}{8}$, then the weight of the beam per foot length will be:

$$W' = (0.885 + 25 \times 0.003)\ 5000 \times {}^{25}/_{100} = 1200 \text{ lb. per. ft.}$$

If we wanted to find, approximately, the depth of the beam, we would have:

$$d = (0.885 + 25 \times 0.003)\ 209 \times {}^{25}/_{100} = 50 \text{ in.}$$

Working out the bending moment formula it will be found that the depth of the beam should only be 49.25 in. The error, therefore, is insignificant in a beam of this size, specially if only an estimate is wanted. In working out the formula, the writer has assumed the weight of concrete at 144 lb. per cu. ft. This is a very fair average and it renders calculations somewhat easier from the fact that a prism one square inch in section and one foot in length will weigh one pound. He has also assumed $f_c = 650$ lb. per sq.in., $f_s = 16{,}000$ lb. per sq.in. and $n = 15$.

Location of Bending Point for Diagonal Reinforcement.

The accompanying table is designed to show the location of the points where tensional reinforcement is no longer needed in the lower part of the beam and where

TABLE SHOWING THE POINT AT WHICH BARS MAY BE BENT IN A REINFORCED-CONCRETE BEAM SUPPORTED AT THE ENDS

(The figures give the distance from either abutment in 1-100ths of the span)

Number of bars to be bent	Number of bars in the Beam																		
	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	11.4	21.0	25.0	27.6	29.5	31.0	32.1	33.0	34.0	34.8	35.4	35.7	36.0	36.8	37.0	37.5	38.0	38.4	38.4
2	9.3	14.6	18.2	21.0	23.4	25.0	26.5	27.6	28.6	29.6	30.3	31.0	31.7	32.1	32.6	33.0	34.0	34.0	
3	7.3	11.4	14.6	17.1	19.3	21.0	22.7	24.0	25.0	26.0	27.0	27.7	28.3	28.9	29.4	30.2	30.7		
4	5.3	9.3	12.2	14.6	16.4	18.2	19.7	21.0	22.2	23.4	24.3	25.0	25.7	26.5	27.2	27.6			
5	4.4	7.8	10.4	12.7	14.6	16.1	17.8	18.8	20.0	21.0	22.0	22.8	23.8	24.5	25.0				
6	3.6	6.8	9.2	11.4	13.0	14.6	15.8	17.1	19.2	19.3	20.3	21.0	22.0	22.7					
7	3.2	6.0	8.3	10.1	12.0	13.3	14.6	15.8	16.7	17.5	18.8	19.6	20.4						
8	2.8	5.3	7.4	9.3	10.8	12.2	13.6	14.6	15.6	16.4	17.4	18.2							
9	2.6	4.7	6.8	8.4	10.0	11.4	12.5	13.5	14.5	15.5	16.4								
10	2.3	4.4	6.2	7.8	9.3	10.4	11.6	12.7	13.8	14.6									
11	2.0	4.0	5.6	7.2	8.6	9.7	11.0	12.0	13.0										
12	1.9	3.6	5.2	6.8	8.1	9.2	10.3	11.4											
13	1.8	3.5	5.0	6.2	7.5	8.8	9.7												
14	1.7	3.2	4.6	6.0	7.3	8.3													
15	1.6	3.0	4.3	5.6	6.8														
16	1.5	2.8	4.2	5.3															
17	1.4	2.7	3.9																
18	1.36	2.6																	
19	1.3																		

the rods there may be bent up into the beam to form diagonal tension reinforcement.

The distances from the supports, or from the points where B. M. = 0, at which bars may be bent are given in hundredths of the clear span, or of the distance between the points where the B. M. = 0, and they should never be increased but may be decreased *ad libitum*.

Location of Shear Bars.

Another point which the writer has endeavored to facilitate, is the bending of bars and the spacing of stirrups for diagonal tension. The method advocated in the majority of textbooks is open to criticism. Briefly stated the method consists in projecting the neutral axis of the beam, from the point where the concrete does not stand any shear or diagonal tension, at an angle of 45°. Then, from the point of support a line is drawn perpendicularly to the projected axis, meeting it at the point *B* (Fig. 2). Along *BD* any arbitrary length *BC* is taken to represent the diagonal tension = *vb*. The triangle *ABC* is then divided up into as many equal parts as there are bars to be bent. Through the center of gravity of each equal area, lines are drawn parallel to the line *BC*, which meet the neutral axis at certain points. The bars are then bent to follow these lines.

In the first place, it is quite unnecessary to project the axis at an angle of 45°. Any angle would do equally well, provided that the line *DB* is made perpendicular to *AB*. The lines through the centers of gravity of each equal area would always meet the neutral axis exactly at the same points. Then the bars could be drawn through these points at whatever angle we pleased. Of course, this angle would have to be decided upon previously, as the strength of the bars is affected by their inclination.

As a matter of convenience, it is better to draw the

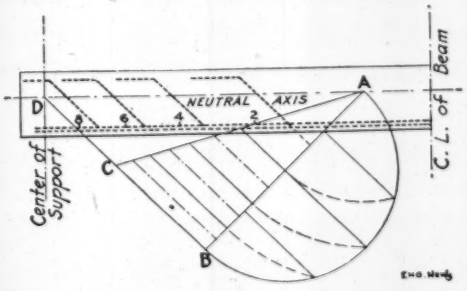


Fig. 2. Usual Method of Spacing Diagonal Reinforcement

triangle, and make the required divisions *above* the neutral axis, without making any misleading projections.

Moreover, the method is faulty because we cannot bend the bars wherever we please. Supposing the diagonal tension in a particular beam could be taken up by, say, four pairs of bars, we would probably find that, owing to the horizontal tension at the bottom of the beam, the bars could not be bent to suit the particular points where the lines through the centers of gravity, above mentioned, cut the neutral axis. It is clear that the method would, then, absolutely fail.

For instance: if, in the beam shown in Fig. 2, we had 10 bars, and we found that 8 bars bent in pairs, as shown in the figure, sufficed to take up the diagonal tension and proceeded to bend them according to the method in question, we would find that the tension side of the beam would be too weak, for the bars should not be bent any further away from the support than the points marked 2, 4, 6, 8. Of course, bending the bars at these points throws the method out of gear.

Another objection to this method is that it could only be applied when the shear diagram is a triangle, but this is far from being always the case. Shear diagrams very often present a broken outline, in which case the method could not be employed.

The writer follows a method of his own which is applicable to any shear diagram. It is as follows (Fig. 3):

Above one-half of the beam draw the diagram of shear, to any convenient vertical scale.

Having decided how many bars are to be bent, find from the table, or by calculation, the points of bending.

At the points thus found, bend the bars at any suitable angle.

Where the bars meet the neutral axis of the beam, erect perpendiculars into the diagram of shear. The length, within the diagram of shear, of these perpendiculars will represent so many pounds.

Divide the number of pounds which the section of a bar or couple of bars can stand in tension by the number of pounds represented by the corresponding perpen-

dicular, within the shear diagram, and the result will be a particular length.

Along the base of the shear diagram, set off half of this length on either side of the perpendicular and at the extremes draw two perpendiculars. The area inclosed by these perpendiculars, in the shear diagram, will represent the shear taken up by the bar, or couple of bars.

This process is repeated for each bar or couple of bars.

It frequently happens that the bars cannot take up all the shear. In this case there will be left what we might call "blank" spaces in the shear diagram. The shear represented by these "blanks" must be taken care of with stirrups. Having selected the size of the stirrup to be used, set out an area in one of the "blanks" next to the space corresponding to one of the bars, equal to the amount of shear each stirrup will stand, and along a line passing through the center of gravity of this area place a stirrup. And so on till the shear diagram has been "filled up."

It will be observed that this method is only an approximation for, as regards the bars, the line which ought to pass through the center of gravity of the area representing the shear sustained by the bar is taken as an average, and from it the length along the base of the diagram is found. This makes the shear coming on the bar somewhat eccentric and the stress on the bar will be correspondingly increased. The error, however, will depend on the form of the shear diagram, and in the majority of cases will be negligible.

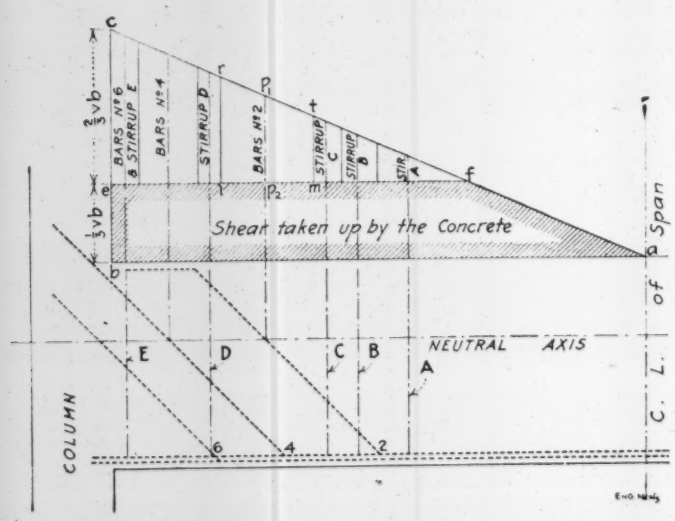


FIG. 3. NEW METHOD OF SPACING DIAGONAL REINFORCEMENT

However, we can always be on the safe side if, instead of setting out the length equally on either side of the perpendicular from the point where the bar cuts the neutral axis, we set the length $^5/_{12}$ to the left and $^7/_{12}$ to the right of the perpendicular. This is, of course, when the center line of the beam is to our right.

This simple correction will give us an area whose center of gravity will be almost on the perpendicular from the bar. The area obtained in this fashion will represent a smaller shear than what the bar can stand, but the discrepancy is very small, and the bar will be all the safer.

To find with mathematical precision the area representing the shear sustained by a bar whose center of gravity would be on the perpendicular corresponding to the bar, an enormous amount of time would be consumed, altogether out of proportion with the result obtained.

The method adopted by the writer will be illustrated by the following example:

In Fig. 3 we have a beam with 10 bars, of which 6 are to be bent in couples.

From the table, we find the points where these bars may be bent. These are indicated in the figure by the numbers 2, 4 and 6.

On half the beam, draw the triangle *abc* representing the shear. Along *bc*, measure off *be* equal to the shear allowable for the concrete per inch length of the beam. Draw *ef* parallel to *ab*. The trapezium *abef* will represent the shear taken up by the concrete.

From the points where the bars cut the neutral axis, draw perpendiculars to that axis, meeting the line *ac*. The length of these perpendiculars intercepted by the lines *ef* and *fc* divided by the tension allowed for each couple of bars, will give the length to be measured along the line *fe*.

Taking the bars No. 2, the perpendicular will represent 800 lb. If the bars are good for 20,000 lb., then the length *lm* will be 25 in. Make $lp_2 = p_2m$. The area *lrtm* will represent the shear taken up by bars No. 2.

Repeat the process for the other bars and insert stirrups to take care of the areas not taken up already by the bars.

Two Common Faults in Detailing Windbracing

By H. Arthur*

While designers of steel structural work are usually careful in determining stresses and sections of the members, they rarely specify on their drawings the sizes of connection angles and other details. It happens often that the resulting structures are considerably weakened because smaller connection angles are put in than the designer would have approved or specified.

The details are usually decided on in the drawing room of the successful bidder. The detailer or draftsman naturally has the interest of his employer first in his mind, and makes the connection as economical as possible, both in weight and in fabricating cost. He never thinks of using an angle more than ⅜-in. thick, in accordance with fixed office-practice. The checker also is not likely to make a very careful study of the details, but limits himself to seeing that the sizes of material are as specified by the engineer's drawing, that the required number of rivets are provided, and that due economy has been observed in the detailing. He knows that the engineer subsequently passes on the plans and approves them as to strength. But when the drawings reach the engineer the details probably receive cursory examination, the engineer's principal enxiety being to verify the main sections of the members.

A specific case is presented by the details at the foot of the kneebrace *dm*, Fig. 1, shown separately by small sketch. Here the connection angles used are 4x4x⅜-in., with a gage of 2½ in. in each leg. The outward pull on the pair of connection angles is 15,000 lb.; the two angle legs riveted against the face of the column being considered as a beam fixed at the ends, the moment produced

*Log Cabin Inn, Stearns, Polk Co., N. C.

(central load 15,000 lb., span 53⅜ in.) is $\frac{1}{8}\times15{,}000\times 53\frac{3}{8}$, or about 10,000 in.-lb. If the allowable extreme-fiber stress is 20,000 lb. per sq.in., the ⅜-in. leg of the angle could take a moment of $10\frac{1}{2}\times\frac{3}{8}^2\times 20{,}000\div 6$, or about 5000 in.-lb. As the actual moment is 10,000 in.-lb., the angle is dangerously overstressed. It should be at least $\frac{9}{16}$-in. thick.

Similar deficiency in detailing is often found at the detail at the top of the column. In Fig. 1, for instance,

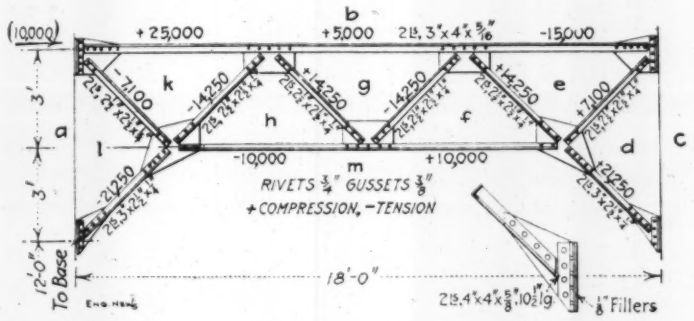


FIG. 1. PORTAL FRAME AND KNEEBRACE DETAIL

the connection of the portal frame to the top of the right-hand column is subjected to a pull equal to the stress in *be* less the horizontal component in *ed*, or 10,000 lb. pull, and the connection angles should be designed so that they will be safe under this load.

Another point of neglect is found in connection with the members *fe* and *dm*. It will be seen from the stresses marked in Fig. 1 that while *dm* has a stress of 21,250 lb., the stress in *fe* is 7,000 lb. less. The detailer, who has his attention fixed on the object of keeping the weights down as low as possible, will use two angles of different sizes for the two members, e. g., 3x2½x¼-in. angles for the lower length and 2½x2x2¼-in. angles for the upper length, spliced by the gusset-plate. Nine out of ten trusses of this kind show compression members made up in the way described, althought good construction requires that *dm* and *fe* should be in one piece extending from the foot of the kneebrace to the top chord.

It will be recognized at once that the two members *dm* and *fe* together are a single compression member, and that if they are made in two lengths with the thin flexible gusset-plate connecting them at the middle the strut will simply buckle out at the gusset-plate instead of resisting its load. When this happens, the entire work of

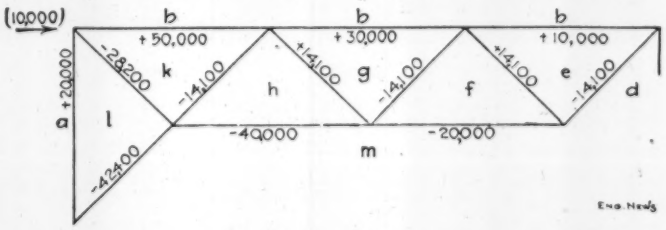


FIG. 2. PORTAL STRESSES WHEN COMPRESSION KNEEBRACE GOES OUT OF SERVICE

bracing the portal is thrown on the tension kneebrace. The result of this is shown by the stress diagram (Fig.2), from which it appears that the stresses are doubled or more.

Even where such a kneebrace and web strut is called for in one length, the detailer will invariably break it at the center and ship the kneebrace loose, for ease of shipment and erection. The erection difficulty will be eliminated if the foot of the kneebrace is kept away from the face of the column by a clearance of about ¼-in. This clearance should always be provided, and the kneebraces should be the last thing riveted up in the entire frame. The inaccuracies of shop and erection can be taken up by the clearance in conjunction with a number of thin fillers behind the kneebrace connection angles. However, the total thickness of fillers should always be kept scant rather than full, as in the latter case a rise of temperature would tend to buckle the truss out of its plane.

⁂

Range-finder Stations for Forest Fires*

The inability of a danger-zone patrol system to locate fires remote from the danger zones suggested the erection of lookout and signal stations on the highest peaks, 10 to 15 miles apart. To locate fires definitely, it became necessary to devise a mechanical range-finder, since experience proved that the use of compass and protractor and the more complicated range-finder equipment introduces innumerable errors, due to the unskilled labor available and to the hurry and excitement incident to discovery of fire.

TOWERS

The cost of material and erection of five wooden towers, including construction of roads and pack trails, stub telephone line, and equipment, was $2100, or an average of $420 each. The net cost of towers and range-finding device alone was not over $300 each. Steel towers 40 feet high can be erected at $400 each. The steel structures would be more economical, and there is not a great difference in first cost. However, it is well to consider the danger from electrical storms, which would be greatly increased by the use of steel, a danger likely to be much magnified in the minds of the class of people who could be employed as temporary fireguards.

The tower proper has an addition 12x12 ft., for living quarters for the fireguard, who is required to remain in the tower day and night during the fire season. It was possible in most cases to employ men with small families for the lookout work. The bottom of the tower, which is also 12x12 ft., afforded another room for their use. The towers were from 20 to 30 ft., high, according to the topographical conditions.

The roof of the wooden tower is a truncated pyramid and of the steel tower a truncated cone, to furnish a flat upper deck approximately 5 ft., square. This deck is rain proof and made accessible by a hatchway 18x24 in. A movable ladder leads from the second story to this opening.

In the center of the superstructure a 25-ft. revolving signal mast is erected, with crossarm and halyards for lowering and raising lanterns, the different positions of which constitute a series of predetermined signals. If this mast is made of iron pipe, a rod may be extended through it, upon which is mounted a vane which registers on a dial over the watchman's head in the cupola below. The dial is laid off and oriented to conform to the points

*Extracts from Bulletin No. 113, Forest Service, U. S. Department of Agriculture: "Methods and Apparatus for the Prevention and Control of Forest Fires," by Daniel W. Adams, Forest Examiner. Copies of the bulletin may be procured from the Superintendent of Documents, Government Printing Office, Washington, D. C.; price, 10c.

of the compass, so that when a fire is sighted he may determine the bearing of the prevailing wind.

The Range Finder

In the second story or cupola of the lookout station there is a sighting hood made with vertical wires 2½° apart, set around the outer circumference. These wires are numbered clockwise from 1 at the north, toward the east, clear around to 144, which gives the 360° of the circle. The wires are 20 gage, tightly drawn. It was found necessary to use thumb nuts threaded on larger wires, to which the small wires were spliced, so that they could be kept taut under varying atmospheric conditions.

In the center of the sighting hood a self-winding plumb bob is suspended; this is drawn down when a fire is sighted and the number of the wire in line between the plumb line and the smoke is noted.

These signal stations are connected both by telephone and signal apparatus. The guard who first sights the fire asks the next nearest signal station for the number of the wire in line with the smoke from his tower. Then by glancing at a map upon which the lines from the wires are projected each guard would instantly note the exact location of the fire by following the numbered lines to their intersection. The lines correspond to the lines of sight through the plumb line to the circle of wires in the sighting hoods. The sighting hood is equipped with a high-back swivel chair, somewhat of the nature of a box with an open side. This protects the watchman, and affords a shelter for maps at his right and a place to secure a telephone at his left.

Portable Range-Finder Station

In addition to the wire-cage device, a portable instrument for range finding has been designed. The base of this instrument is set off into 180 divisions, 2° apart, instead of the 144 vertical wires in the first-described apparatus. This gives a somewhat finer subdivision of the field, and it has the further advantage of a mounted telescope with powerful lens, which will result in a better determination of the location and size of the fire. On top of the telescope barrel there are front and rear sights (similar to those of a rifle) to be used when it is too smoky or dark to use the lens.

A pointer in line with the long axis of the telescope registers in numbered indentations on the base of the supporting plate. When a fire is sighted, the telescope is focused upon it, and the number read at the pointer corresponds to a deflection line on the base map of the forest. As with the wire finder, the intersection of these lines can be determined by the next nearest signalman making a similar reading. The base plate has spirit tubes and leveling screws so that it may be adjusted to any surface and brought to a level.

This base plate enables the apparatus to be set up on any form of tower or, indeed, on a mountain top where there is no tower, provided there is an unobstructed view on all sides. In such a case it is sufficient to have a rough foundation of logs supporting a flattened log upon which the instrument may be fastened by lag screws.

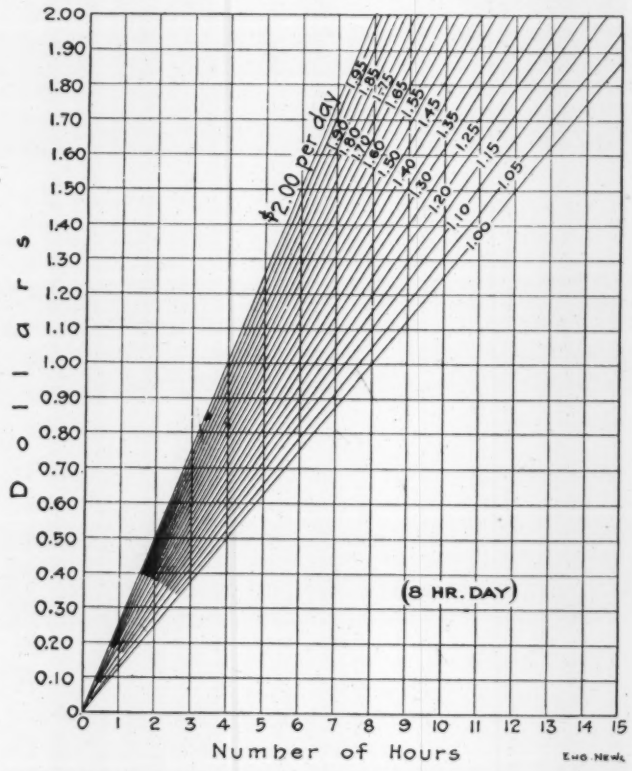
Where it is necessary to erect towers for this apparatus, light wind-mill towers would be sufficient. Such towers are light, and come in detached sections which could be packed to the tower site without having to construct special roads and trails. The sites of the towers must be predetermined, and triangulation maps made to conform to these sites. The cost of the windmill towers is approximately $30 to $50 at points of manufacture.

The approximate cost of the range-finding instrument complete is $75. Allowing $40 for the tower, $10 for transportation, and $25 for installation, the total cost is only $150. With this apparatus it is not necessary to orient the tower or foundation to conform to the public-land surveys, since the instrument itself can be shifted.

This range-finder is suitable for cheap and improvised installation, and the telescope gives it a sufficient accuracy. Yet, where an established protection is desired the permanent tower station previously described should be used. This is especially true because it provides living quarters for the watchman, and a sheltered position from which to keep watch and make observations.

Fractional Wage Diagram

Diagrams like the one shown in reduced size herewith have been made by Russell H. Peck*, Palmerton, Penn., for quickly finding part-day payment based on a fixed day rate. The pay can be read correct to a cent. The original of the illustration was drawn on a standard sheet of cross-section paper (about 8½x11 in.) in millimeter ruling, and, the height of the sheet being taken as $2, a height of 1 mm. (1/25 in.) represents 1 cent.



Pay Diagram for Part of a Day, Based on 8-hr. Rates

(Original diagram, on 8½x11-in. cross-section paper, reads to cents).

The diagram shown covers various day-rates with an 8-hr. day. A similar diagram would be drawn for a 10-hr. working day, etc.

The diagram is extended to 15 hr. using the same rate as for the regular day. If a special rate for overtime is to be used, it can be handled just as readily by drawing the diagonal lines as broken lines (with the upper part of different slope from the lower part.)

*Engineer for the Palmer Land & Water Co.

A Frog-angle Triangle for Plotting Turnouts

By W. W. Gruber*

A very convenient device for plotting frog angles, in laying out railway turnouts, and one which has for some time proved a great time-saver to the writer, is shown in Fig. 1. Any draftsman can easily make a "frog-angle triangle" by simply placing lines on it which make angles with the edge equal to the various frog angles. The frog number is determined by the length in feet from the

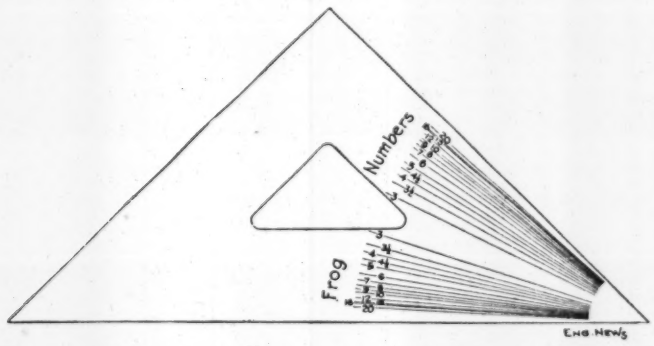


Fig. 1. Triangle Graduated for Frog Angles and Used for Plotting Turnouts

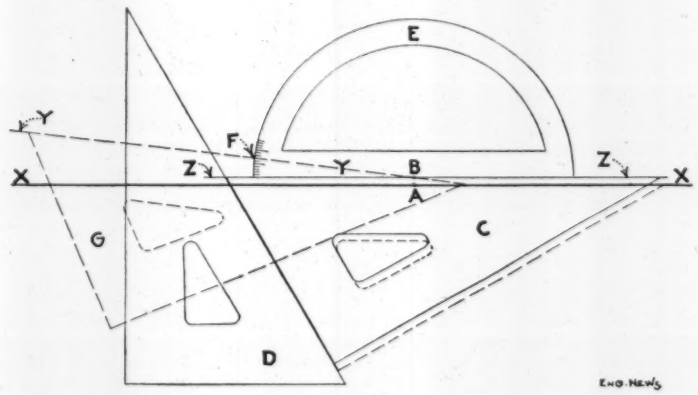


Fig. 2. Method of Plotting a Turnout with a Protractor

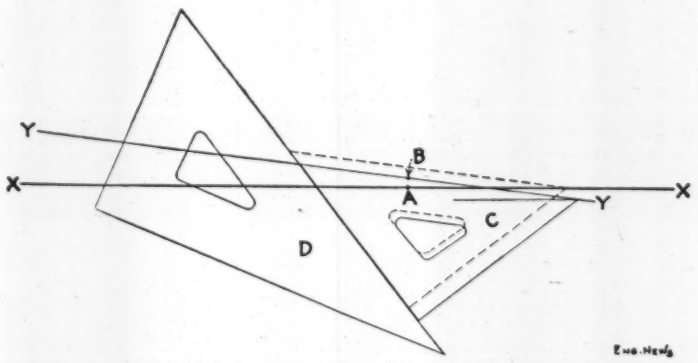


Fig. 3. Method of Plotting a Turnout with a Graduated Frog-angle Triangle

point to a place where the spread is 1 ft. Or, mathematically, it is half of the cotangent of half the frog angle. For instance, a No. 8 frog angle would be the angle at the vertex of an isosceles triangle 8 ft. high with a 1-ft. base. The frog numbers and their respective angles are given in the accompanying table.

These angles for the various numbers of frogs are easily plotted on the triangle with a soft pencil, after which the lines may be scratched in with the aid of another triangle and prick point. The lines should be made from both edges, so that right-hand and left-hand frogs may be plotted without turning the triangle over, thus always keeping the graduations next to the paper that they may coincide perfectly with the line the angle is being plotted from. Figures designating the frog number for each angle should be put on the opposite side of the triangle from that on which the lines are drawn, or they may be stamped backward on the same side as the lines. In scratching the lines, they should be made by a light pressure and gone over several times, so as to avoid the slipping of either triangle.

Fig. 2 shows the ordinary method of plotting the center line of turnouts through frogs, and Fig. 3 the method by use of the frog-angle triangle. The respective methods are described below:

1. Plotting Frog Angle with Protractor (Fig. 2)—The heavy line X-X represents the center line of the main track, and a No. 8 frog (angle 7° 9′ 10″) is to be located at A. Plot the center line of turnout through this frog. From point A, measure a distance of 4 ft. 8½ in. at right angles to X-X, locating point B, which is in the center line of the turnout and directly opposite the frog point. Place the triangle C with its edge on the center line X-X, as shown by the dotted lines. Holding the triangle D firmly against it, slide the triangle C to bring its upper edge against the point B, as shown by the full lines. Then draw a line through B, as Z-Z. Place the protractor E on the line Z-Z, and plot point F at the desired angle (7° 9′ 10″). Place one of the triangles at G, as shown by the dash lines, with its edge touching points B and F, and through these points draw the line Y-Y, which is the desired center line of the turnout with frog at A.

2. Plotting Frog Angle with Frog-angle Triangle (Fig. 3)—With the conditions as above, place the graduated frog-angle triangle C so that its line 8 (for No. 8 frog) coincides with the main-track center line X-X, as indicated by the dotted lines. Place the triangle D against it. Holding this firmly, slide the graduated triangle C so as to bring its upper edge against the point B (previously plotted at 4 ft. 8½ in. from the designated position of frog-point at A). Draw a line through point B, as Y-Y, and this will be the desired center line of the turnout with frog at A.

*Office of Engineer of Maintenance of Way, Kentucky & Indiana Terminal R.R., Louisville, Ky.

Cost of Erecting a Steel Bridge

The adequacy of the cost figures for erection of a three-span railway bridge given by M. A. O. Stilson (our issue of Feb. 20, p. 362) is questioned by Frederick Tench (Terry & Tench Co., Inc., Grand Central Terminal, New York City), who says:

> A glance at his cost list simply shows labor and a small percentage charged in for certain items of plant, without provision for tools, fitting-up bolts, coal, liability insurance, overhead charges, freight and traveling expenses, which naturally have got to come in in figuring up accurate costs.
>
> The rate of wages specified is $3 a day for bridge men; this rate has not been in existence for 15 years, and the present rate is $5 per day in New York and vicinity and in other locations throughout the country, while foremen's rates run very much higher than are listed.

In reply Mr. Stilson says that the various general-expense items not included in his list, while adding to the total, would not materially increase the cost per ton.

He states that the job was done 8 years ago. The article gave the working time for the different operations, and from this the cost for any particular wage schedule can be figured. Mr. Stilson discusses the several points as follows:

The item of fitting-up bolts chargeable to the job would hardly show in the tonnage price. Very few bolts were stripped or lost overboard and the tools lost in this way amounted to so little as to be immaterial. The item of insurance is handled in different ways; I am ignorant of the method used in this case, as I am also in regard to what treatment was given the accidental drowning of the night watchman preceding the tampering with some of the scaffolding. In regard to coal, no forced draft being used in an eight-hour day, the amount (for the two boilers a little over a ton per day, or for three weeks 20 tons, at $3.75 is $75) also changes the ton price but little.

The value of such a record of cost as was given lies as much in knowing the discrepancies of it as compared to another piece of work under consideration for estimate as in using it absolutely as a basis of cost. The fact that this piece of work has been in service about eight years seems to me simply to emphasize the need of applying present rates to it as to a formula.

The difference of opinion really revolves itself to the wage question, and I am sure an experienced erector will not consider $8 a day a low wage for superintendence. He will perhaps see in it some explanation of the lowness of the other scales, due to the man's efficiency in handling any class of men. I know of work at present being done under $5 a day, and also that were the gangs economically built up around an experienced nucleus (bull gang also considered) as were the gangs on this work, the average rate of wages paid would scale down considerably. Further, the remark on wages explains no doubt why this bridge was erected by this organization and not by the company fabricating the steelwork. A glance at the last paragraph, giving the number of days in which the erection was completed, will perhaps tell more to the experienced man as to the evident low cost (i.e., efficiency) than a comparison of wage schedules. It was undoubtedly a well-handled job.

As to traveling expenses it happens that this same organization did considerable erecting within a short radius, so that this item was also small.

C. S. Davis (Consulting Engineer, Spitzer Bldg., Toledo, O.) makes remarks similar to those of Mr. Tench as to omission of various expenses and use of low wage rates, though he does not go as high as Mr. Tench's $5 per day. He makes the following summary of cost data for the job in question, using *hours per ton* as unit for labor:

Taking the figures, as I understand them, given by Mr. Stilson, I would analyze the cost as follows:

COST OF ERECTING A THREE-SPAN DOUBLE-TRACK RAILWAY BRIDGE, WEIGHT 1761 TONS

(1) Transportation of men and tools (not given), say	$300	$300
(2) Falsework:		
Lumber, 40 M. ft. B.M. at $30	1200	
6 M. ft. B.M. at $25	150	
Piling	390	
		1740
(3) Traveler:		
Lumber, 10 M. ft. B.M. at $35	$350	
3 M. ft. B.M. at $25	75	
Hardware	54	
		$479
(4) Labor or payroll (all time figured on basis of 8-hr. day):		
(a) Placing tools		
Foreman, 1 man 4 d		32 hr.
Labor, 12 men 4 d		384 hr.
(b) Traveler		
Foreman, 1 man 4 d		32 hr.
Labor, 6 men 4 d		192 hr.
(c) Erecting falsework:		
Foreman, 1 man 4 d		32 hr.
Engineman, 1 man 4 d		32 hr.
Labor, 4 men 4 d		128 hr.
Foreman, 1 man 8 d		64 hr.
Labor, 8 men 8 d		512 hr.
(d) Erecting traveler		
Foreman, 1 man 6.5 d		52 hr.
Engineman, 1 man 6.5 d		52 hr.
Labor, 4 men 6.5 d		208 hr.
(e) Unloading:		
Foreman, 1 man 18 d		144 hr.
Engineman, 1 man 18 d		144 hr.
Labor, 8 men 18 d		1152 hr.
(f) Erecting three spans (say three times span No. 3):		
Superintendent, 3x30 d		720 hr.
Foreman, 3x38 d		912 hr.
Engineman, 3x43 d		1,032 hr.
Labor, 3x832 d		19,968 hr.

SUMMARY OF LABOR

Superintendent	720 hr. or 0.41 hr. per ton
Foreman	1,268 hr. or 0.72 hr. per ton
Engineman	1,260 hr. or 0.72 hr. per ton
Labor	22,544 hr. or 12.8 hr. per ton

A contractor, with the above information at hand, and with labor at a wage more in keeping with present practice, would estimate a bidding price about as follows:

COST ESTIMATE

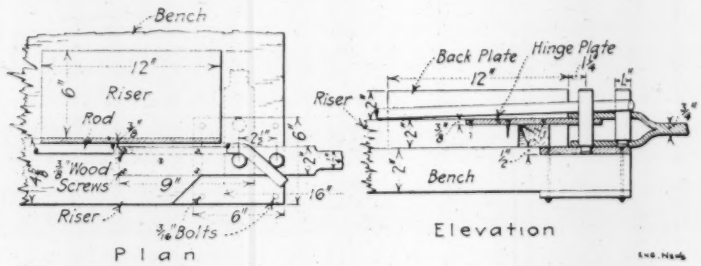
Transportation		$300 or $0.17 per ton	
Falsework		1740 or 0.99 per ton	
Traveler		479 or 1.43 per ton	
Labor:			
Superintendent	0.41 hr. at $1.25	$0.51	
Foreman	0.72 hr. at $0.75	0.54	
Engineman	0.72 hr. at $0.60	0.43	
Labor	12.8 hr. at $0.50	6.40	
Total labor pay roll			$7.88
Liability insurance [varies, say 6% of payroll]			0.47
Sundry expenses, say 10% pay roll			0.79
Overhead expense, say 10% pay roll			0.79
Total cost per ton			$11.36
Add for profit 10%			1.14
Contractor's bidding price per ton			$12.50

In making the analysis above, it was necessary to estimate the number of hours erecting traveler from the labor cost which was given. The scale of wages used in making the estimate of cost was taken at random, but approximately near what a contractor would have to pay for this kind of work.

NOTES

A Cheap Rod-bending Machine—The following sketch and description of a cheap home-made machine for bending steel rods, which has been found satisfactory for use with bars up to ¾ in. diameter is sent by Clark F. Towers, Ossining, N. Y. The apparatus may be fastened to any heavy bench and its cost complete would be about $2.50.

Its structural details are shown clearly in the accompanying cut. A 6x6x½-in. steel pivot plate with a 1-in. diameter steel pin riveted in its center is bolted onto the bench



PLAN AND ELEVATION OF AN IMPROVISED BENDING MACHINE FOR STEEL RODS UP TO ¾ IN. DIAMETER

flush with the top and sides. The pin extends up about 4 in. from the face of the pivot plate. The forked lever is forged from 2x⅜-in. steel, is about 33 in. long and has its handle end drawn out to take a pipe handle. Another 1-in. diameter steel pin is riveted to the bottom prong and projects up through the top prong, and both prongs are bored out to fit over the first-mentioned pin. A hinge plate of 2x⅜-in. steel is bored near the outer end to receive the same pin and the inner end is screwed to a wooden riser on the bench. Removable steel back plates of 2x⅜-in. steel 1 ft. long complete the equipment.

In the Aug. 26, 1909, and the Sept. 28, 1911, issues of "Engineering News" there were illustrations of two other forms of rod-bending machines both of which differed from the one above described in having line contact between dies and rod instead of the point contact of the above apparatus. The earlier issue describes a bending machine, ratchet operated, which method seems to be more convenient for heavy work than the simple lever.

Decay of Wooden Piles in Tidewater was examined by the Prussian Royal Materialprüfungsamt in the case of a sheet-pile wall in the Weser River. The piles were in place nine years. The mean tide range was from — 2.3 ft. to + 8.2 ft. There was marked decay around El. 0. The lower limit of decay was found to lie between — 1.5 and — 3 ft. Samples cut at various points between — 6.5 ft. and 0 showed a regular decrease of crushing strength as zero elevation was approached. [From 1911 annual report of the Materialprüfungsamt, Gross-Lichterfelde West, Germany].

Another Broken-line Column-formula—The three-segment column-formula used in the new structural specification of the American Bridge Co. (our issue of Feb. 20, 1913, p. 365), brings a proposal for a three-segment formula of different outline from E. B. La Salle, 159 Harrison St., Batavia, Ill. Taking the plate-and-angle column tests made at Watertown Arsenal and reported in "Engineering News," Aug. 26, 1909, and fitting a series of straight lines to the results, he determined the following vertex-points: 35,000 for length equal to 25 r; 33,000 for length equal to 50 r; 30,000 for length equal to 125 r (these three values being the same for flat-end and pin-end columns); and, for length equal to 175 r, the value of 25,000 for flat-end and 20,000 for pin-end columns. The three lines joining these four points represent the ultimate strength. They are represented by the following formulas:

$$\text{For } \frac{l}{r} = 25 \text{ to } 50.$$

$$\text{ultimate strength} = 35{,}000 - 80\left(\frac{l}{r} - 25\right)$$

$$\text{For } \frac{l}{r} = 50 \text{ to } 125.$$

$$\text{ultimate strength} = 33{,}000 - 40\left(\frac{l}{r} - 50\right)$$

$$\text{For } \frac{l}{r} = 125 \text{ to } 175.$$

$$\text{ultimate strength} = 30{,}000 - 100\left(\frac{l}{r} - 125\right) \text{ (flat ends)}$$

$$20{,}000 - 200\left(\frac{l}{r} - 125\right) \text{ (pin ends)}$$

Assuming that this series of lines truly represents the ultimate strength of such columns, Mr. La Salle compares the working values given by the new American Bridge Co. three-segment formula and the straight-line formula of the American Railway Engineering Association with his line of ultimate strengths, and determines the factor of safety which the other two formulas give. He finds the following factors: For the A. R. E. formula, from 2.45 for the shortest columns up to 6.67 for the longest columns. For the A. B. Co. formula, from about 2.50 for short columns up to 5.88 for very long columns. He concludes:

> I believe that an actual safety factor of 3 is the least that should be used for work of any importance; also that formulas should be used which do not cut off too fast as the length increases, since this is wasteful of material.

This conclusion involves two doubtful points: (1) The question whether Mr. La Salle's line does represent the actual ultimate strength of columns, and (2) the question whether columns should be designed with a uniform factor of safety, or whether a different factor should be used for long columns from that used for short columns. His line is concededly based on a single small series of tests, while most column formulas used in practice are supposed to be based on comparisons covering nearly all available column-test records.

Relative Age of Lines on Drawings—In a lawsuit against C. A. P. Turner (Minneapolis, Minn.), some time ago, the authenticity of a drawing was questioned, the charge being made that some of the drawing had been added after the original date. It therefore became necessary to determine, if possible, whether certain lines of the drawing had been drawn before or after others. Prof. A. Zeleny, of the Physics Department, University of Minnesota, studied the matter for Mr. Turner. It was found that microscopic examination gave pretty clear information on the order of production of intersecting lines. While the case finally did not depend on the microscopic proof, the results of the study as reported by Mr. Turner are given below:

Placing the drawing under a high-power microscope, magnifying the lines to about ¾ in. width, the thickness of the ink layers showed up clearly, together with cracks which had developed in drying. Where one line was drawn subsequent to the other, the new ink in the later line had filled all cracks in the older line and softened up the older ink; then as the two layers dried together, new cracks had developed, continuing into the area of the new line beyond the intersection with the old; this revealed specifically the order of the drawing, even where the ink used was somewhat thin and the line of demarcation indistinct.

Subsequent to this examination, the original drawing in question was lost. There remained as evidence only blueprints from it, a bromide negative, and a 14x17-in. photographic negative. Some indications were found on the blueprint to indicate with certainty the order in which the lines were drawn on the original. By throwing light up through the bromide print and enlarging, but without using high magnifying power, the majority of intersections showed the relative order of drawing in the line. The photographic negative was clearer than the bromide. All uncertainty, however, it is believed, can be removed in such cases, if the original tracing is placed under the microscope.

While the above statement does not touch a number of questions involved in such an examination (e.g., what difference in age of the lines is necessary to give distinct indications), the method can be tried on known test samples by anyone who has occasion to use it. If the subject has been studied by others and definite conclusions obtained we shall be glad to learn of the results.

When the Frost Is on the Transit. Extra-heavy winter conditions affect instruments as well as men. The transit shown by the adjoining picture appears to be badly frost-bitten. It is a Keuffel & Esser transit. P. W. Jones, of Denver, Colo., informs the makers that the instrument had been left untouched in a blowing frost for half an hour at 11,600 ft. elevation. Some overhauling was probably required after the transit was thawed out.

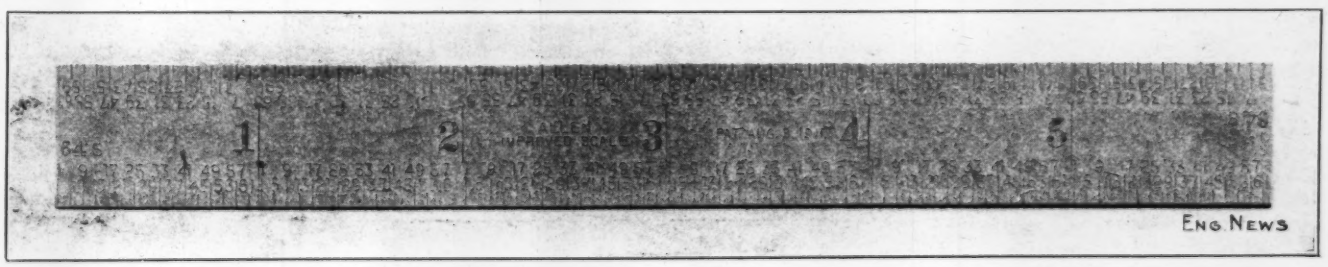
COLORADO WINTER

The Meaning of Theodolite—As the term "theodolite" is used by makers of surveying instruments, its meaning is rather indefinite. The distinction prevailing between theodolite and transit at one time, namely that the telescope of the theodolite could not be reversed through the standards, no longer holds. Dictionaries (which are always behind technical practice in special terminology) do not agree on the distinction between transit and theodolite. One maker of surveyors' instruments writes:

> "We have used the word 'theodolite' to distinguish between our U-standard and double-standard construction."

This does not agree, however, with the practice of other makers, who apply the term "transit" to U-standard instruments as well as to those of the older form of construction.

A Readable 64th Graduation—The scale graduation shown in the halftone below is a new and very convenient arrangement of graduation which permits of getting dimensions to $^1/_{64}$ of an inch with a scale having only sixteen lines to the inch. How this is accomplished can be seen at once from the cut. The face of the rule shown has along one edge a scale whose graduations are on the points corresponding to $^1/_{64}$, $^5/_{64}$, $^9/_{64}$, etc., and along the other edge a scale



SPECIAL GRADUATION ON "ALLEN IMPROVED SCALE," GIVING 64TH-IN. READINGS WITH $^1/_{16}$-IN. SPACING

corresponding to 3/64, 7/64, 11/64, etc. The even sixty-fourths appear on the other face of the rule in the shape of a 16th scale and a 32ds scale of ordinary arrangement. The scale shown is the "Allen Improved Scale," made by the Lufkin Rule Co., Saginaw, Mich.

Buckling in Webs of Beams—The following derivation of a formula for the buckling tendency of the web of a steel beam is given by W. W. Pearse (of Radley Steel Constr. Co., New York City). He compares his formula with the results of several tests and finds a surprisingly close agreement. The form of the formula is like that of the Gordon column formula, but the method of derivation fixes the constants in this formula, as follows:

The end shear on the beam is regarded as being absorbed wholly by that part of the web lying between the flanges, this being also the unsupported depth of web. Taking a length of the web equal to this unsupported depth, the longitudinal shears at the upper and lower edges must equal the vertical shear. While all these shears are distributed along the edges of the web section to which they are applied, they may for the present purpose be taken as concentrated at the middle points, and each resolved into two diagonal components as shown in the sketch Fig. 1, herewith. It will be seen that the components w act as compressive forces on this piece of web, while the components w' are tensile forces. To a certain extent the tensile forces would probably help to stay the web against the buckling action of the forces w, but it will be safer to consider only

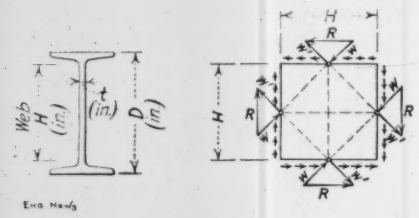


FIG. 1

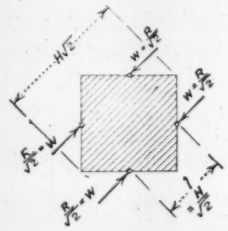


FIG. 2

the resistance of the unstayed web to the compressive forces. The total compression on the piece is 2w, and, comparing this with the end shear R, it will be seen that 2w is equal to the $R\sqrt{2}$. Dividing the web (Fig. 2) into strips parallel to the line of action of the compressive forces w, it appears that all these strips must be buckled if any of them is to fail, or in other words, the resistances of all the strips add together in making the total resistance to the buckling forces. These strips all differ in length, but the average length may be taken as half the diagonal of the web section, or $\frac{1}{2}H\sqrt{2}$. The middle cross-sectional area of the column is equal to the length of the diagonal times the web thickness t, or $A = tH\sqrt{2}$, and the compression per square inch is equal to $\frac{2w}{A} = \frac{R}{Ht}$. The column formula is taken from Merriman's "Mechanics of Materials," 1894 edition, page 132, as follows:

$$\frac{P}{A} = \frac{Sc}{1 + \frac{Sc}{m\pi^2 E}\frac{l^2}{r^2}}$$

The factor m is equal to 4 in the present case, corresponding to fixed ends. From Prof. E. Marburg's tests of I-beams, reported in "Engineering News," Aug. 12, 1909, Mr. Pearse takes the following values for beams 15 in. deep and less: E = 26,900,000 (average); Sc = 46,100 (average). With these values substituted, the equation gives

$$R = \frac{46{,}100\,Ht}{1 + \frac{H^2}{4000\,t^2}}$$

which is the value of the end reaction that will buckle the web in I-beams 15 in. or less in depth. For 24-in. and 30-in. I-beams he concludes that Marburg's tests authorize the values E = 25,300,000; Sc = 32,000; which make the end shear formula

$$R = \frac{32{,}000\,Ht}{1 + \frac{H^2}{5300\,t^2}}.$$

Some tests are given in the Bethlehem Steel Co.'s large handbook (1907), page 88. For 10-in. I-beams with web 0.13 in. thick and H = 66.5t, the limiting end shear was 24,750 and 24,300, or average 24,525. The formula above quoted (the first of the two) gives R = 24,670.

Tests of 8-in. I-beams with web thickness 0.125 in. and H = 54.6t showed a limiting end shear of 22,900 and 21,850, average 22,375. The formula gives R = 22,300.

Tests for 6-in. I-beams gave 22,650 and 22,900. The formula gives 21,600.

A Test for the Proper Degree of Concrete Mixing was proposed by J. F. Owens in a paper before the Concrete Institute of London on Jan. 30, 1913. In this test a funnel, provided with a conical 12-mesh wire screen, is fitted into the top of a test glass and a sample of the concrete mixture (just mixed) is poured into the funnel and the glass shaken until all the material which will pass through the mesh has dropped into the glass. At the same time a small stream of water is allowed to trickle through the concrete. The stones retained on the mesh are then thrown away or retained for measurement if desired, but are not necessary to this test. The test glass, having been filled with water, is shaken up and placed to settle. It is then found that the sand and the cement will settle in about 10 min. into well defined layers. The relation of these layers to each other can then be measured and the proportion of the sand to the cement in the concrete thus ascertained. It is the idea of the inventor of this test that if the sand and cement are thoroughly mixed there is no doubt but that the large aggregate will be well mixed also. He proposes that an inspector of concrete mixing should every so often make this test in order to determine the degre of mixing. He states that it is easy to distinguish by this test a 1:2 mortar from a 1:2½ mortar for instance, whereas by mere inspection it has been found that it is quite difficult to distinguish a 1:2 mortar from even a 1:3½ mortar.

Preservatives for Stone have been under test for four or five years in Germany. The report on the results after four years' exposure is given by Prof. F. Rathgen, of Berlin, in "Zeitschrift für Bauwesen," No. 1, 1913. The stones under test comprise seven or eight varieties each of sandstone, limestone, and marble. The preservatives under test are two kinds of "fluates," "Testalin," "Zapon," "Szerelmey," beeswax, and carnauba wax. The two-year results were reported in the same journal in 1910. Neither the two-year nor the four-year tests give any very definite ranking, but in so far as indications can be found in either set of tests they do not agree. The four-year tests tend to show that sandstone is protected somewhat by magnesium fluate and by Zapon; that limestone is protected somewhat by Szerelmey, and marble by beeswax (but the protection of the beeswax is slight after the first two years). The tests are being continued, and more stones are being included in the comparison. Further, through the assistance of the Prussian government, in 1911 and 1912 applications of three kinds of preservative were made to numerous stones in old and new buildings in twelve cities of Prussia for the purpose of large-scale experimentation. In the case of these larger tests it is presumably necessary to judge by surface appearance rather than by weighing.

❖

Diagram for Wheel and Truck Clearances of Cars

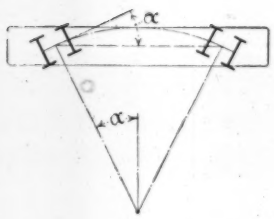
BY WILLIS BOOTHE*

The diagram herewith is intended to facilitate the work of laying out the location of points on the circumference of a truck wheel at any point above the rail, in relation to the center line of the car, when rounding a curve. The scope of the diagram is such as to include all conditions met in dealing with 33- and 36-in. wheels, truck spacing varying from 12 to 60 ft., and radius of track curvature ranging from 30 to 200 ft.

The diagram primarily is a graphic representation of a series of results in the determination of angle α (see sketch above diagram), combined with a means of indicating directly the bevel in inches per foot corresponding to each value of angle α. This bevel is given to obviate the necessity of using a protractor in the layout work.

The wheel is considered as being cut by a series of horizontal planes spaced 1 in. apart; the distances *A* and *B*, which are the distances from center line of wheel to the points on the high part of flange and the extreme

*501 Wabash Bldg., Pittsburgh, Penn.



SECTIONAL DIMENSIONS				
ABOVE RAIL	33" WHEEL A	33" WHEEL B	36" WHEEL A	36" WHEEL B
17	1'-5 3/16"	1'-4 3/16"	—	—
18	1'-5 9/16"	1'-4 1/8"	—	—
19	1'-5 7/16"	1'-4"	1'-6 3/32"	1'-5 3/32"
20	1'-5 3/32"	1'-3 13/16"	1'-6 23/32"	1'-5 19/32"
21	1'-5 1/32"	1'-3 9/16"	1'-6 23/32"	1'-5 7/16"
22	1'-4 3/4"	1'-3 3/32"	1'-6 9/16"	1'-5 1/4"
23	1'-4 13/32"	1'-2 5/16"	1'-6 11/32"	1'-4 31/32"
24	1'-3 31/32"	1'-2 5/16"	1'-6 1/32"	1'-4 21/32"
25	1'-3 1/16"	1'-1 23/32"	1'-5 23/32"	1'-4 1/4"
26	1'-2 23/32"	1'-1 1/8"	1'-5 1/4"	1'-3 25/32"
27	1'-2 5/32"	1'-0 1/32"	1'-4 3/4"	1'-3 1/4"
28	1'-1 11/32"	0'-11 5/32"	1'-4 5/32"	1'-2 13/32"
29	1'-0 7/16"	0'-10 5/16"	1'-3 1/2"	1'-1 7/8"
30	0'-11 11/32"	0'-8 5/16"	1'-2 23/32"	1'-1
31	0'-10 1/32"	0'-7 3/32"	1'-1 7/8"	1'-0
32	0'-8 5/8"	0'-4 1/16"	1'-0 22/32"	0'-10 5/16"
33	0'-6 7/32"	0'-0	0'-11 21/32"	0'-8 5/8"
34	0'-2 1/32"	—	0'-10 1/4"	0'-7 9/16"
35	—	—	0'-8 1/2"	0'-4 23/32"
36	—	—	0'-6 1/32"	0'-0
37	—	—	0'-0	

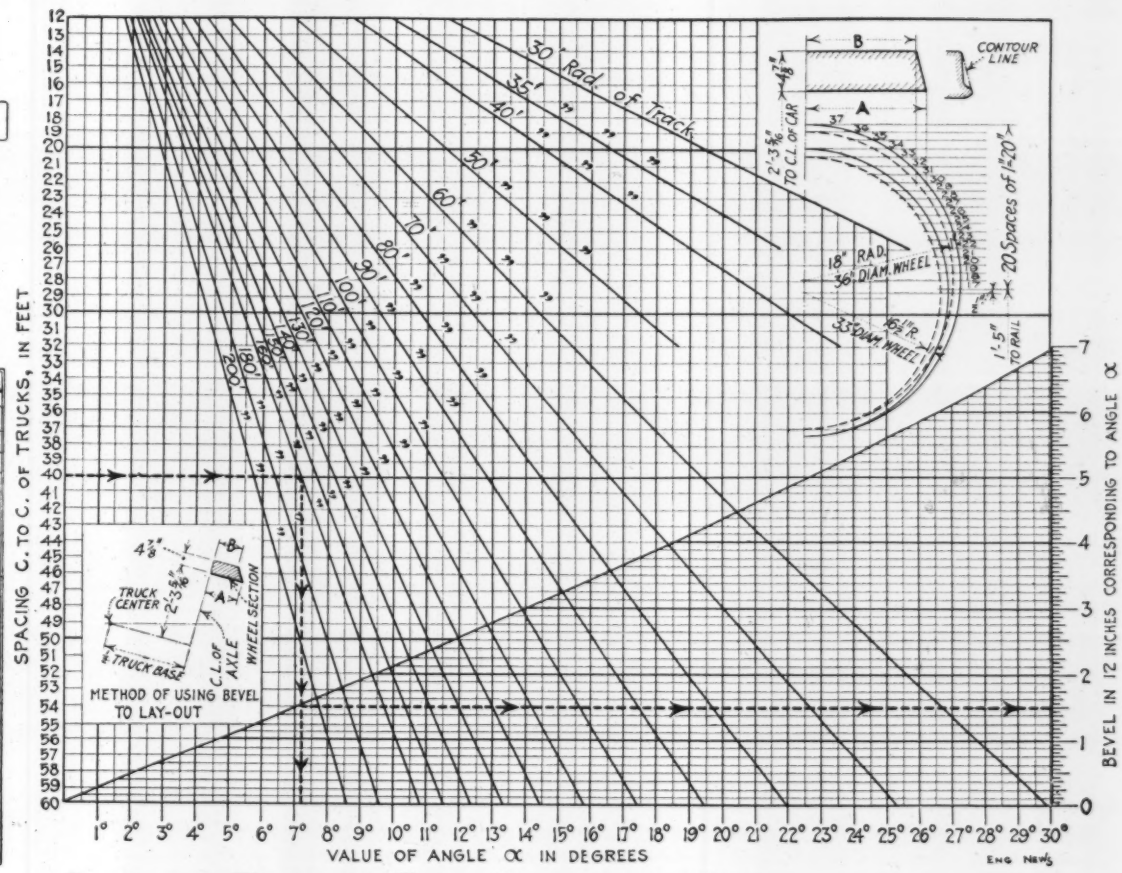


DIAGRAM OF WHEEL AND TRUCK CLEARANCES OF CARS

part of tread, respectively, for each horizontal plane, are tabulated at the left of the diagram.

For illustration: It is desired to know the location of a point 30 in. above the rail, on a 36-in. wheel, when truck spacing is 40 ft. and radius of curvature of track is 160 ft. From left-hand edge of sheet, graduation 40, read across sheet to diagonal designating 160 ft. radius, thence down on the vertical line to opposite inclined diagonal and across the sheet to bevel scale, 1½ in. bevel in 1 ft. By following the vertical line passing through intersection of 40 ft. graduation and 160 diagonal to bottom of sheet the value of angle a may be read 7° 12′. The table gives the distances A and B for 30-in. height on a 36-in. wheel as 1 ft. $2\frac{23}{32}$ in. and 1 ft. 1 in., respectively. These quantities enable the point in question to be located by layout or by computation.

❋

Formulas for Radial Distances Between Curves

By George Paaswell.*

In many designs of railroad structures, especially subsurface structures, it is a matter of prime importance to get distances between tracks normal to a center line of survey, which is itself a curve. To obtain these distances is a matter of tedious and laborious trigonometrical calculation.

The writer offers a short method which, though approximate, is sufficiently exact for all purposes. For subways where bents are spaced 5 ft. apart and are set normal to a center line this method has proved satisfactory and time-saving. All calculations are made by ordinary slide-rule, except that for the distance D, which is obtained by simple trigonometric formulas.

*Public Service Commission, 154 Nassau St., New York City.

Referring to the accompanying sketches Figs. 1 to 4, let

R = radius of circle to which distances are radial.
r = radius of the other curve,
L = distance required,
a = angle as shown, expressed in radians,
D = distance between centers.

For the different sets of conditions shown in the four sketches the exact formulas are:

Fig. 1, $L = -D\cos a + \sqrt{r^2 - D^2 \sin^2 a} - R$

Fig. 2, $L = D\cos a + \sqrt{r^2 - D^2 \sin^2 a} - R$

Fig. 3, $L = D\cos a - \sqrt{r^2 - D^2 \sin^2 a} + R$

Fig. 4, $L = -D\cos a - \sqrt{r^2 - D^2 \sin^2 a} + R$

These are simplified by expanding the first and second terms with the help of Maclaurin's Theorem, so as to eliminate trigonometric terms and get a series in powers of the angle a.* The resulting equations, omitting all terms above a^4, are:

$$L = -R + r - D + D/2\,(1 - D/r)\,a^2 - D/24\,(1 - 4\,D/r + 3\,D^3/r^3)\,a^4$$

$$L = -R + r + D - D/2\,(1 + D/r)\,a^2 + D/24\,(1 + 4\,D/r - 3\,D^3/r^3)\,a^4$$

*Maclaurin's theorem states

$$f(a) = f(o) + f_1(o)\,a + f_2(o)\,\frac{a^2}{1.2} + f_3(o)\,\frac{a^3}{1.2.3} + \ldots.$$

where f(a) is the original function and f(o), $f_1(o)$, $f_2(o)$, etc., are the values of the function and its derivatives when the variable is equated to zero. In applying it to the expression

$$D\cos a + \sqrt{r^2 - D^2 \sin^2 a} - R$$

the first term becomes the cosine series.

$$D\cos a = D\left(1 - \frac{a^2}{1.2} + \frac{a^4}{1.2.3.4} \ldots\right)$$

The expansion of the second term, $\sqrt{r^2 - D^2 \sin^2 a}$, is more complicated. It comes out as a series with only the even powers of a, which can be foreseen because it is an even function, i.e., has the same value for positive and negative a, and therefore cannot contain odd powers of a. Adding the coefficients of the respective powers in this expansion and in the Dcos a series, the result is obtained in the form

$$L = K_1 + K_2\,a^2 + K_3\,a^4 + \ldots.$$

$$L = R - r + D - D/2\,(1 - D/r)\,a^2 + D/24\,(1 - 4\,D/r + 3\,D^3/r^3)\,a^4$$

$$L = R - r - D + D/2\,(1 + D/r)\,a^2 - D/24\,(1 + 4\,D/r - 3\,D^3/r^3)\,a^4$$

These may be rewritten in the following forms:

For Fig. 1, $L = A + C\frac{D}{2}a^2 - E\frac{D}{24}a^4$

For Fig. 2, $L = F - G\frac{D}{2}a^2 + H\frac{D}{24}a^4$

For Fig. 3, $L = -A - C\frac{D}{2}a^2 + E\frac{D}{24}a^4$

For Fig. 4, $L = -F + G\frac{D}{2}a^2 - H\frac{D}{24}a^4$

where

$A = -R + r - D$ $\qquad F = -R + r + D$

$C = 1 - D/r$ $\qquad G = 1 + D/r$

$E = 1 - 4\,D/r + 3\,D^3/r^3$ $\qquad H = 1 + 4\,D/r - 3\,D^3/r^3$

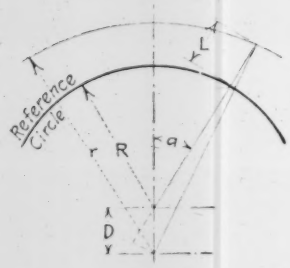


FIG. 1

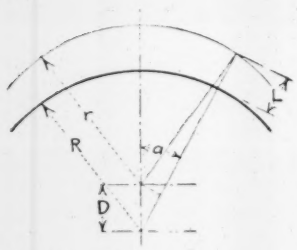


FIG. 2

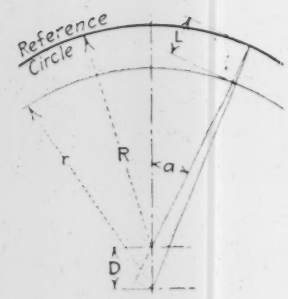


FIG. 3

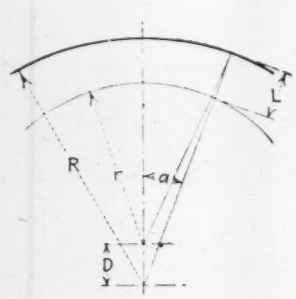


FIG. 4

FIGS. 1 TO 4. TO FIND RADIAL DISTANCE OUT FROM CURVED CENTER-LINE R TO CURVE r

The values of the coefficients C, E, G and H may be obtained from the graphs reproduced in Fig. 5. Compute the ratio $\frac{D}{r}$, and enter the curves with this value.

In general we may put

$$L = P + \frac{D}{2}Qa^2 + \frac{D}{24}Sa^4$$

The term Sa^4 need only be used when its value for the largest value of a becames appreciable.

A table for the conversion from degrees into radians is given herewith.

If the stations along the R circle are equally spaced, then only the first angle need be computed. The length of one station divided by the radius gives the difference to be applied to the first angle obtained. Thus the various values of a are quickly tabulated. The squares, and if need be the fourth powers, are read off on the slide-rule. The coefficients Q and S are taken from the curves in Fig. 5; then the values of Qa^2 are tabulated with one setting of the slide-rule, and similarly the values of Sa^4.

TABLE FOR CONVERTING DEGREES, MINUTES AND SECONDS INTO RADIANS

Degrees	Radians	Minutes	Radians	Seconds	Radians
1	0.0175	1	0.0003	10	0.0000
2	0.0349	2	0.0006	20	0.0001
3	0.0524	3	0.0009	30	0.0001
4	0.0698	4	0.0012	40	0.0002
5	0.0873	5	0.0015	50	0.0002
6	0.1047	6	0.0017	60	0.0003
7	0.1221	7	0.0020		
8	0.1396	8	0.0023		
9	0.1571	9	0.0026		
10	0.1745	10	0.0029		
20	0.3490	20	0.0058		
30	0.5236	30	0.0087		
40	0.6981	40	0.0116		
50	0.8727	50	0.0145		
60	1.0472	60	0.0175		
70	1.2217				
80	1.3963				
90	1.5708				

Since the approximation in the formulas consists in dropping the higher powers of a, it is well to check one or two values by substitution in the exact formulas. Should an appreciable error be noted it is better to use the exact formulas in the range affected by the error rather than carry the expansion further. The value of L obtained by the approximate and exact formulas for the maximum a will at once show whether the approximate formulas apply for all cases.

For example: In Fig. 1 take $R = 1000$; $r = 1050$; $D = 25$. Assume the allowable error to be $\frac{1}{8}$ in., or 0.01 ft. The ratio $D/r = 0.02$. From the graphs, $Q_1 = 0.98$, and $-S_1 = 0.92$. Then

$$L = 25 + 12.25a^2 - 0.96a^4$$

To see for what value of a the term $0.96a^4$ becomes appreciable, equate $0.96a^4$ to 0.01, whence $a = 0.345$, or 20°.

Suppose the maximum value of a is 30°, or in radians 0.5236. From the approximate formula $L = 28.28$. Substituting in the exact formula

$$L = -D\cos a + \sqrt{(r^2 - D^2\sin^2 a)} - R$$

$L = 28.28$, the same result; which shows that the abandoned powers of a exert no influence on the result.

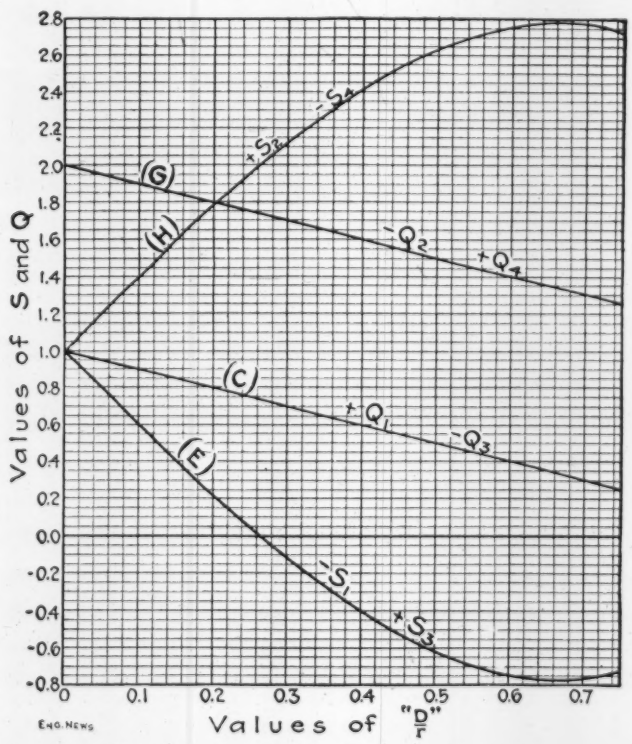


FIG. 5. COEFFICIENTS Q AND 4

EDITORIALS

In railway advertising literature nowadays, one notices frequent appeals to the passenger's desire for safety in his journey. "Block signals" are more frequently the foundation of the advertiser's appeal than "Cannon Ball Flyers." The climax is reached, however, in the following paragraph from a publicity man's account of two new five-hour express trains between Boston and New York.

These new trains are practically indestructible. Made of steel they could go through a stone wall without being scratched. Reinforced underneath with two immense steel girders running the length of the car and attached at the end to a solid cast steel U frame forming the vestibule, no impact, however great, could telescope them. A rear-end collision might tilt them up on end a bit, but that would be all. So far as resisting powers go they are built like battleships.

We fear the publicity man is unaware how thick are the stone walls that surround some of New England's rock-ribbed farms. We have no word to say against the excellent provisions for strength in car construction but it is well to remember that the greater the weight of a car the greater the impact in a collision. To talk of "indestructible trains" is a little too much like the talk of "unsinkable ships," to which the "Titanic" disaster put an end. In these days when the public is prone to demand too much of the railways the latter should be very careful not to claim too much.

One Man Control for the New York State Highway Work

The bill of Governor Sulzer, of New York, to abolish the present State Highway Commission (created in accordance with a law passed during Governor Dix's administration) and to place the entire highway work of the state under the jurisdiction of a Commissioner of Roads, became a law on Mar. 15. Comment on this measure has already been made in these columns. We will merely observe at this time that three successive governors of New York have each of them changed, not merely the men in control of the state highway work, but the organic law under which that control is exercised.

It is a pretty safe guess that the end is not yet reached. It would be a very remarkable thing if the next governor of New York, whoever he may be, should leave Governor Sulzer's appointee in charge of the state highway work. Should the Governor appoint an honest and thoroughly efficient engineer to take charge of the work, such a man would doubtless accumulate sufficient influential enemies during his term of office to make his reappointment an impossibility. On the other hand, if Governor Sulzer gives the job to a politician, then rival politicians will surely have some other man slated for the place by the time another governor is inaugurated.

How long would a mercantile or manufacturing firm be able to keep out of bankruptcy if it changed its president and manager every two or three years, and if all those holding responsible positions in the firm knew that they were likely to lose their places at any time when a change in management occurred? New York has a long way to travel before it learns the elementary principles of efficient public works management.

Engineering Work Which Pays

In the current discussion in these columns concerning the status of the engineer, it is well to put on record that there are cases where the work of the engineer *is* appreciated. We have before us a newspaper interview with the head of a noted bridge engineering concern, which interview bears every evidence of authenticity, in which he says: "We complete about $10,000,000 worth of bridges each year and we have erected altogether at least $120,000,000 worth of bridges in this and foreign countries. Our gross annual income is about $300,000 and our net profits about $100,000. We have a staff of about 70 to 80 engineers."

If the above figures may be accepted as correct, this firm's charges for its engineering work averages 3% of the cost of the structure. The figures quoted furnish another illustration of the tendency toward the concentration of engineering work in the hands of large organizations.

Another very pleasant newspaper story, which will sound strange to many engineers, but which we have verified from independent sources, concerns a prominent engineer who had carried through a very large enterprise for a well known capitalist. The manner of execution of the work so pleased the man of wealth that he not only paid the engineer's bill, but as an evidence of his high appreciation sent the engineer as a Christmas present a check for $20,000. May his tribe increase!

The Conviction of Well Known Men for Fraudulent Mine Promotion

In the United States Court at New York City, on Mar. 14, Julian Hawthorne, Dr. W. J. Morton, and Albert Freeman were found guilty of fraud in connection with the promotion of Canadian mining companies, and were given a penitentiary sentence. Josiah Quincy, ex-Mayor of Boston, who was indicted with the others, was acquitted, but indictments on other counts are yet to be tried.

The trial of these men has attracted wide attention, partly because of their prominence and partly because of the remarkable literature which was circulated by these men in promoting their mining properties. Julian Hawthorne is the son of the famous American author, and has for practically his whole life made his living by literature, although he studied as a young man at the Lawrence Scientific School and in the early '70's he spent two years in hydrographic work as an engineer in the New York Dock Department.

Three or four years ago, at the time of the public excitement over the silver discoveries in the Nipissing and

Cobalt region, Freeman, Morton and Hawthorne organized companies to develop mining claims in this region. To sell the stock of these companies, Hawthorne prepared and circulated literature in which the most extravagant claims were set forth as to the value of the properties. These circulars were prepared with a literary ability which made them widely read, and had doubtless a large influence in securing the sale of the stock.

From the information developed during the trial, however, it may well be doubted whether the profits of those who engage in the task of promoting fraudulent enterprises are as great as is often claimed. Apparently the money received from the sale of stocks was rapidly used up in paying the cost of sending out circulars, renting expensive offices, and keeping up a show of work on the Canadian mining claims. It is doubtful whether the promoters gained much profit other than salaries which lasted no long time, for it did not take long for the bubble to burst.

There is no doubt that the verdict and the sentence of Hawthorne and Morton were abundantly justified by the facts which the trial developed. Doctor Morton is the son of the Dr. Morton who first used ether as an anæsthetic. Both Hawthorne and Morton used the names which their fathers had made famous, as a bait for investors in an enterprise of whose character they could not have been ignorant. Their conviction and punishment is a valuable and salutary warning as to the danger of connection with any enterprise of a dishonest nature.

The sentence most richly deserved, however, is that meted out to Albert Freeman, for this is not the first time that Freeman has been the active agent in promoting fraudulent mining concerns by the aid of distinguished names. Many members of the engineering profession will recall the circulation of literature a dozen or more years ago, in which roseate prospects were held out to investors in certain mines located in the Leadville district of Colorado and in Mexico, and the names of a number of distinguished and blameless engineers, a number of whom have since that time passed away, were advertised as assurance of the soundness of the enterprise.

Had the Federal Government at that day enforced the law against the use of the mails for fraudulent purposes with the same vigor and persistence that it has in the last three or four years, there is little doubt that Mr. Freeman's career as a financier would have come to an end long before the days of Cobalt and Temagami.

Rules against Smoking on Street Cars

Ever since the introduction of street cars there has been more or less protest against permitting passengers to smoke on the cars. In recent years the protest has become stronger and more insistent, with the result that in a number of cities smoking has been prohibited entirely. A brief editorial reference to this matter was made in an issue of Nov. 28, 1912, but the subject appears to call for some further notice in view of its relation to street-railway administration and economics, and to public comfort, cleanliness and health.

With the old style of cars having open platforms there was little objection to smoking by those on the platforms. Practically no smoke would enter the car, and smokers could (and did) expectorate into the street, so that the platform did not become very dirty. With open cars, also, there is not much objection to smoking on the rear seats, except that the foul condition of the floor is very offensive to non-smokers and especially to women who may have to take seats in this part of the car.

With modern cars having vestibuled or inclosed platforms the conditions are very different. There is no adequate escape for the smoke, and nearly all expectoration is upon the floor. Whenever smoking is allowed in part of the car (as in the vestibules of street cars or in a partitioned compartment on interurban cars), the smoke and the foul odors from the filthy floor invariably penetrate throughout the car. Indeed, on some interurban cars, where the conductor and passengers are continually opening the door in the partition, the conditions in the main body of the car are highly objectionable, even to those who are not averse to smoking.

It may be of interest to refer to some specific instances. The Chicago street railways operate a number of cars having large vestibules, with the main exit at the front. On these cars smoking is permitted in the front vestibule, and the constant swinging of the door in the bulkhead or partition causes smoke and smell to extend through the car. The more serious objection in this case, however, is the filthy condition of the floor of the vestibule from the continual expectoration. The new front-entrance cars of the Chicago lines have no rear vestibule, and the front vestibule or platform is not separated from the body of the car by any partition. No smoking is allowed on these cars.

Three of the four elevated railways in Chicago operate smoking cars on their trains, and there has been complaint as to the condition of these cars, and as to the practice of smokers passing through other cars (which are often crowded) to reach the smoking car. This latter trouble is due in part to the fact that this car is not in the same position on every train. Some time ago, in consequence of numerous and persistent complaints, the Chicago & Oak Park Elevated Ry. decided to prohibit smoking on its trains. There were violent protests on the part of smokers; some banded together to use other transportation lines, with the idea that the loss of their patronage would bring the company to terms. Others adopted the plan of smoking in the regular cars, but this nuisance was abated partly by ejecting the offenders and partly by stopping the train until the smoking was stopped. Fights were somewhat frequent for a time, but all these means of protest failed, and after a short but stormy period, the non-smoking rule was obeyed.

Incidentally it may be noted that the smoking cars and compartments of many rapid-transit lines in London are far less objectionable than those in American cities. This is due to the fact that British smokers seem to get along without continual expectoration, and the further fact that the chewing of tobacco is practiced only to a small extent in Great Britain. Consequently, only the smoke and tobacco ashes are noticeable conditions, while the floor is dry instead of being in the filthy and wet condition which causes a large part of the objections to smoking cars in this country.

At Kansas City, a controversy which involved the city authorities, the street railway company and the public, was settled in 1912 by a referendum vote of the passengers. It appears that in 1910, the company issued an

order prohibiting all smoking on the cars, but in 1911 an agitation was raised by smokers, and in 1912 the City Council was induced to pass an ordinance requiring the company to permit smoking. The company refused to accept the conditions imposed, claiming that the regulation of smoking was a matter entirely within its own hands, and that the prohibition was in the interest of the greater number of passengers. The dealers encouraged the smokers to fight by offering free cigars and tobacco and matches to persons who would smoke on the cars, but this move (as well as that of the Council) was checkmated by the company ordering its employees to stop their cars and refuse to move as long as any passenger insisted on smoking. The complaints of other passengers soon overcame the obstinacy of the offending smokers. Finally, the company decided to take a vote of the passengers as to whether they desired to have smoking allowed in the cars, with the result that nine voted against it for every six in favor of it. This settled the matter, and the prohibition against smoking remains in force.

In New York, smoking is not allowed on the subways, elevated lines or street cars, except on rear seats of open surface cars, on upper seats of the proposed double-deck closed cars being tried, and on open cars run in summer on one of the elevated lines. We understand that the prohibition was due largely to action taken by the Health Department. It has been reported that the street-railway companies of Milwaukee, Wis., and Portland, Ore., have announced that no smoking will be allowed in future upon any of their cars. The companies benefit from the elimination of a special class of accommodation and from the reduction of special cleaning required for cars in which smoking is permitted.

In many American cities there have been similar agitations against smoking on street cars, accompanied by more or less active controversies between smokers and the general public and between smokers and the street railway companies. If the undesirable conditions noted above are admitted (and in many cases there is no room for argument) there would seem to be no good reason to require the transportation interests to maintain a nuisance, simply to meet the convenience of a small proportion of their passengers. That this proportion is small is indicated by the relative amount of space assigned for smokers and non-smokers. The prohibition has no effect in reducing the revenues of the companies, as persons will ride even if they must not smoke during the ride.

There can be no question but that as matters of simplified and economical street-railway administration and of general comfort and convenience of all passengers who do not smoke on urban transit cars the prohibition of smoking is justified. Public cleanliness points in the same direction. Just how far the public health demands the prohibition of smoking in street cars it is not so easy to say—at least not in specific terms, supportable by scientific evidence; evidence, too, which is not equally applicable against smoking in any public place. The spitting so commonly associated with smoking is a possible means of spreading the germs of tuberculosis and other communicable diseases. The smoke-laden atmosphere of a smoking car or compartment is certainly far from an ideal medium of conveying life-giving oxygen to the lungs. It has been claimed also in Chicago, and with some show of reason, that placing the motorman in a vestibule whose atmosphere is heavy with smoke and foul odors does not conduce to his health, comfort or efficiency, or to his prompt and clear-headed action in an emergency.

On the general ground of conserving the interests of the greater number of passengers, the force of the argument seems to be decidedly against permitting smoking. The tendency undoubtedly is in this direction, and where the non-smoking principle has been established there seems to be little, if any, complaint or dissatisfaction after the first protest has been overcome.

❖

The Proposed New Cleveland Charter and the Engineering Organization of Cities

What is the best plan of engineering organization for the larger cities of the United States? The question is pertinent because Cleveland, Ohio, has recently elected a Charter Commission of 15 members by popular vote. The commission is headed by Hon. Newton D. Baker, now Mayor and for many years City Attorney of Cleveland, and seems to be tackling its complex problem with vigor and intelligence.

Although, aside from expenditure on schools, the bulk of the money paid for running our cities goes for engineering work, few American cities have a rational system of engineering organization. Instead, the engineering work is generally distributed in a haphazard fashion among a number of city departments. The boards or commissioners in charge of these departments are but rarely engineers and quite as rarely are they selected because of any marked qualifications for the important duties which they must perform and supervise. The engineers who do the responsible work, and upon whom are heaped all the blame if anything goes wrong, get comparatively little credit for their achievements, are generally paid meager salaries, and, like their political chiefs, are liable to be turned out of office at any election.

There is need for a functional reorganization of the administrative work of most of our cities, both large and small, with a correlation and at least a considerable degree of centralization of the engineering work of the various departments. This much is certain. There is more or less uncertainty as to whether there should be a single and largely independent engineering department for the whole city, or whether each functional department should have an engineering department of its own, largely independent of all other departments.

A middle course is to have a separate engineering staff for each department and a city engineer independent of any and all departments. The city engineer might be a general consulting engineer to the Mayor, under the federal plan of city government, and to the council under the commission plan. The city engineer and the department chief engineers might together form an engineering board which would pass upon all interdepartment or overlapping engineering problems. The city engineer might be chairman of this board and might have a deciding vote; or he might be chairman with no vote, but with power to veto the decision of the other members—which some might think too radical a plan.

The foregoing plan of engineering organization is suggested for purposes of discussion rather than for general adoption, although we believe that some plan of centra-

lized engineering organization is essential to the best possible success in municipal administration. This general principle applies to small as well as to large cities, but the smaller the city the less will be the difficulties of its application, since the number of engineers becomes fewer and fewer until with a small city only the city engineer himself is involved.

Consideration of this or any other plan of municipal engineering organization should be kept separate from the question as to whether or not department heads should be engineers. In any case there must be an engineering staff or staffs. The question is how can the engineering work of all the city departments be harmonized or unified?

Some years hence, all the heads of strictly executive city departments will be selected and retained for fitness, and fitness only, and the chances of partisan politics will no longer determine their appointment. So long as political considerations dominate the selection of department heads, they will continue to rotate into and out of office according to the popular votes on such national issues as the tariff, the currency, and State rights, on the one hand and, on the other, such local issues as the control of various forms of vice. Obviously, none of these considerations has any relation whatever to a man's fitness to manage a city's engineering works; nevertheless, out go the heads of such departments with every change in the political complexion of Mayor and Council.

Fortunately, a goodly number of citizens already realize the folly of such changes, and the number is increasing. Many cities which are not ready to take the heads of public works departments out of politics of the baser sort are quite ready to place their technical staffs above this baneful influence—or they would be ready if they had leadership to that end.

Who could more properly and effectively lead this great reform than the engineers themselves? Not merely the engineers in the city service but all members of the enginering profession. In fact, for obvious reasons, engineering leadership in such reforms would be more effectively promoted if they sprung from or were guided by engineers who were not in the city service. We do not mean by this that engineers in the employ of a city should take no part in the movement. They should take as active a part as is consistent with the proprieties. Heretofore, most engineers in the city service have been altogether too modest in this respect. They might well learn from the lawyers how to keep within professional bounds and yet mold city charters, ordinances and administration in accordance with the best ideas of their profession.

Reverting to the situation at Cleveland, a new charter is being drafted there under auspices favorable to excellent results. The Cleveland Engineering Society has already taken a hand in shaping public opinion regarding important engineering problems. We presume it is awake to its present opportunity and duty.

Frankly, we are not sure that the Cleveland or any general engineering society is fitted to undertake detail work in this field; for the membership of such a society is too complex and the chief interests of many if not most of its members are too remote from problems of municipal administration. But the society as a whole can readily and properly take a strong stand upon such fundamental matters as choosing and retaining the members of the city's technical staff on the basis of fitness alone; and it might refer to a carefully selected committee such questions as demand special knowledge of municipal engineering and administration.

At Cleveland and elsewhere, engineers seeking to do their part in the reform of city charters should of course coöperate with men of other professions. Such cooperation should be easy to secure, for all citizens alike are interested in securing good government and it is easy to show that all branches of the municipal service, and particularly the technical branches, upon which in great measure economy and efficiency depend, can only be well administered by men chosen solely for their ability, amply paid for services rendered and retained in office indefinitely, so that the city may gain the benefit of their years of accumulated experience. In fact, the politicians themselves who realize there is an elastic limit to what the public will stand have found it necessary to retain in office permanently many of the men whose technical knowledge and experience make them indispensable to keep the wheels of public business turning.

Finally, in this and all other civic matters, the engineer should dismiss his diffidence, come out from the shadowy background where he has too often lost himself in the past and do his part in shaping public opinion.

LETTERS TO THE EDITOR

Rapid Railway Bridge Reconstruction in India

Sir—I send you herewith a short account of the renewal of the girders of the Kiul Bridge on the East Indian Ry. The work carried out is of considerable magnitude and is an excellent example of a well-thought out project successfully completed. Owing to the rapidity with which the work has been done a considerable saving has been effected on the estimate; while the inconvenience of having to work on a single line of railway has been reduced to a minimum, the value of which is difficult to estimate.

The first work, completed last March, was the regirdering within three months of starting work of the "Up" road of the Kiul Bridge at Mile 261⅞ on the Main Line of the East Indian Ry., but this fine record has been surpassed in regirdering the "Down" road. The old bridge was of nine spans of 150-ft. lattice girders weighing 141 tons per span, with footways supported on brackets on the outside girders. Before the work of erecting the new girders could be put in hand the old girders had to be dismantled, involving the cutting out of 103,000 rivets. The piers had to be demolished and new bed stones set at a lower level for the reception of the new girders. The new girders are of the open N type of 150

ft. clear span and were designed by Messrs. Sir A. M. Rendel and F. E. Robertson, Westminster, London. Each girder weighs 160 tons and 15,000 rivets per span were required in their erection.

The work of dismantling the old girders of the "Down" road was started on Nov. 14, 1912, and the track was laid across the new bridge on Jan. 11, 1913. So far as we are aware the rapidity with which this work has been carried out has never been equaled in India, let alone surpassed. For all practical purposes it means that one span of old girders was dismantled and a new span of 150-ft. girders completed with track every seven days.

The officers in charge of the work were A. H. Aslett, District Engineer, J. Leitch, Resident Engineer, C. O. Meredith, Bridge Foreman and Maurice Melling, Contractor.

A. H. ASLETT.

Dinapore, Bengal, India.
Jan. 14, 1913.

Licensing Engineers

Sir—In the discussions of the problem known as "licensing engineers," the customary point of view has generally been that the engineer alone was to be consulted. A recent news item reveals a different point of view.

The item states that the National Association of Paving Brick Manufacturers at its recent meeting in Chicago, adopted resolutions favoring laws that will require examinations for civil engineers and engineers engaged in construction work of all kinds.

The resolutions indicate that probably more than one member has been "stung" in times past.

If it is necessary to have a house cleaning, would it not be better to have it done in the interest of engineers or rather by those composing the so called profession? There is a strong feeling among the younger generation that the older members have prevented action in this matter because they are employers and that has biased their judgment. In these prosperous days when a great many engineers do not belong to engineering societies, etc., because they cannot afford the price, a good many votes on this question are never registered. How to get an accurate vote is a problem in itself. To my mind it has not been had at the present time. If you take an impromptu gathering you will not find a very strong belief in the average employer, whether he is an engineer or not, and it seems too much to expect that those on that side of the fence will be anxious to further a scheme which may apply a cut to themselves. The employers are well represented in all votes while the employee probably keeps still because he does not desire to "squeal" and make a public announcement that he is a failure according to modern standards.

In our large cities an average man 15 years out of school cannot get married unless he wishes to live way back on a back street. At 50 he is not wanted. When in his lifetime is he supposed to be prosperous? At the same time concerns whose profits rest entirely upon engineering information, acquire more than they know what to do with, judging by the way the beneficiaries spend it. There is an economic law governing the matter and it is not very obscure.

P. L. B.

Chicago, Mar. 10, 1913.

The Railway Valuation Act

Sir—The title of your interesting editorial in ENGINEERING NEWS of Mar. 6, on the Railway Valuation Act, "A Huge Piece of Engineering Work," seems to be well chosen. Indeed it is conceivable if not probable that the work provided for by this Act is only the preliminary survey of what may develop into a task far greater than has yet been suggested in the public discussions of the subject.

Your statement that "A fair valuation, which will settle questions now in dispute, will be of great public service" will generally be accepted as true. But what is a "fair valuation"? As the writer views this question, a mere physical valuation may be decidedly unfair for some or all of the purposes intended.

From the viewpoint of one who has had the opportunity to work for some years on a number of railway economic problems, the only fair valuation is one that includes the operating value and an estimate of the efficiency ratio of operation and management as well as the economics of such revisions and betterments as appear feasible.

To make such a valuation for over 362,000 miles of track would be a stupendous undertaking but it could be done. When the insufficiency of the proposed physical valuations becomes apparent, perhaps the larger task may be undertaken.

The question is, would it not be safer and better to go slow and make a complete economic and operating valuation from the start, even if it should take two or three times as many years to complete the work for all the railways which come under the operation of the act.

A. W. BUEL.

15 William St., New York City.
Mar. 7, 1913.

[Our correspondent raises a question which will eventually have to be given serious attention. If the public is not willing that efficient management shall be given recognition in some form in fixing railway rates, what incentive will there be to run the railway business efficiently? And the question is broader than the railway business alone. If any public utility may charge such rates as will enable it to earn a fair rate of interest on the value of its plant, then it may raise rates by simply neglecting to run its business economically, allowing labor costs and material prices to run up.

This is but a sample of the economic and political questions that must be threshed out before the big problem of public control of public utilities under private ownership is successfully solved. The valuation of these utilities now provided for is merely a beginning.—Ed.]

The Detroit Machine for Testing Paving

Sir—I read with some interest the discussion between Mr. Powell of the Universal Portland Cement Co. and Mr. P. E. Green, regarding concrete pavements, in your issue of Feb. 27. It may be of interest to you to know why the machine called the "paving determinator" was constructed. It is a well known fact that no matter what article of commerce you place in the hands of a salesman, he will be able to dig up excellent quali-

ties for the article and induce a great many buyers to take his word for it.

Detroit has yearly spent a great deal of money for the construction of brick pavements. The manufacturers who are able to furnish a brick of a very low abrasion loss in the standard rattler naturally claim great excellence for their product. The experience of the Department of Public Works, from actual wear of the paving blocks in the streets, did not confirm the assumption that the block with the lowest rattler loss gave the best service. Representatives of the manufacturers claimed that the failure of the low abrasion block not giving the best service, was because of the faulty construction of the pavement. The facts in the case did not warrant this charge. In order to determine just where the trouble was, this "paving determinator" was designed and tests were run with various kinds of material. Mr. Green says:

> Any machine, which, by test, produces results that are contrary to hard experience, simply brings ridicule on scientific observations and theory. The absurdity of a concrete pavement outwearing a first-class granite block pavement needs no comment.

In regard to this statement, we did not find that concrete outwore granite. We did find, however, that under the conditions at which one test was run at speeds varying from five to seven miles per hour, with all the paving (concrete included) laid to a straight-edge, owing to the roughness of the surface of the granite pavements the grouting was broken and the granite blocks forced into the sand to a depth of 1 in. or more and the edges of the blocks were chipped in places. However, there was very little actual wear on the granite block.

We have made rattler tests on the granite block and found that rattler loss was about 3% on fresh blocks with sharp corners, and only 1½% on the same block on a second test. We have also rattled sandstone block and concrete blocks, obtaining in the sandstone about 11% and the concrete about 40%. I have also found individual vitrified blocks in the product of one of the very best brands of paver that has run as high as 60% loss.

Our observations were made for the purpose of finding what relation, if any, the rattler indicates as to actual wear, and we believe we are in a fair way to learn this. We have found that the greatest weakness in a vitrified block pavement is in the behavior of the sand cushion. In our tests the floating or shifting of the sand has been the inciting cause of the failure of the brick. It would be natural to say that the filling of the joints must have been defective to admit of this.

In regard to the creosote block being loosely laid, I understand that this was used, not as a test on creosote block, but only to introduce the wheels to each successive sample of concrete in the same manner.

The work done in Detroit was entirely for the information of the Department of Public Works, and is by no means completed at the present time. The machine is nothing more or less than a method of providing wheel abrasion on a pavement surface in a concentrated manner, and may at times show that a presumably inferior material, properly laid, may give superior results over a supposedly superior material improperly laid.

J. C. McCabe.
City Boiler Inspector.

Detroit, Mich.
Mar. 13, 1913.

The Three-segment Column-formula; Increasing Column Stresses

Sir—The publication in your issue of Feb. 20 of extracts from a new set of specifications applying to the design of steelwork for buildings, etc., issued by the American Bridge Co., brings up again the time-honored question of formulas for the reduction of allowable unit-stresses in columns.

The new three-segment formula as suggested resembles very much that used by the Bethlehem Steel Co. in figuring its table of "safe loads" for the special H-section column rolled by that company. In fact, between the limits $\frac{l}{r} = 40$ and $\frac{l}{r} = 80$ these formulas will give practically the same allowable unit-stress, and it is between these limits that probably 85 to 90% of the tonnage of columns fabricated for building work will occur.

If then, we confine our attention to a comparison of the formulas (as shown on the diagram published with your article referred to above) between these limits, it can readily be seen that the new three-segment formula (and hence also that used by the Bethlehem Steel Co.) allows a much higher unit-stress than any other formula except that contained in the Boston Building Law, which law at the same time imposes extreme conditions of loading in connection with the use of its formula, conditions that cannot be actually realized. Both of these formulas differ from the old "Gordon" formula, which is the one on which the majority of tables of "safe loads" given in the various hand-books are based, by as much as 13 % where $\frac{l}{r}$ equals 55.

It would be proper to know, therefore, upon what data the new American Bridge Co. formula and the Bethlehem Steel Co. formula are founded. It is recognized, of course, that column formulas are to a great extent empirical, but those upon which current practice in regard to the strength of columns is based were founded on the results of actual tests combined with the best theory applicable. The new formulas mentioned seem to be based on assumptions which may or may not be well founded. If there have been tests made the results of which would warrant the adoption of a formula that will permit the use of unit-stresses in columns in some cases 13% higher than has heretofore been considered good practice, the writer is not aware of it. It seems only fair to the engineering profession that the authority for these formulas should be made public, and intelligent and honest criticisms invited from those competent to judge, before they come into general use in tabular forms of alleged "safe loads" in hand-books, among the host of "text-book designers" with whom, unfortunately, the final decision in the matter of far too large a quantity of structural steelwork is placed.

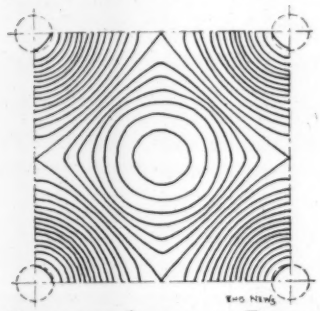
The writer would suggest that an opportunity be given through these columns for a thorough establishment of the merits of the two column-formulas here mentioned. If well founded, they are deserving of universal use where applicable; if not, their existence tends to mislead and may be productive of much harm and injustice.

N. R. McLure.

Phoenixville, Penn., Feb. 25, 1913.

Tests and Performance of Flat Slabs

Sir—In reference to A. C. Arend's letter in ENGINEERING NEWS, Feb. 27, 1913, p. 429, on the subject of flat-slab floors, it may be of interest to your readers to study the accompanying diagram or "contour map" of a flat plate supported on points and loaded uniformly. The illustration given is the result of one of the numerous experiments carried on by this company in arriving at a rational basis of design for floors of the flat-plate type.



CONTOUR LINES OF RUBBER FLAT SLAB DEFLECTED BY AIR PRESSURE
(Reprinted from "Engineering News," Feb. 29, 1912, p. 403)

A sheet of rubber was fastened over an air-tight box, containing columns dividing the surface of the rubber into nine panels. Load was applied by exhausting the air from the box with a water-jet aspirator and measured by a U-tube manometer. Deflection readings were then taken at points over the interior panel spaced one-tenth of the span apart and the readings plotted in the form of a contour map, showing in a remarkably clear manner the character of the surface assumed by a flat plate, supported on points and uniformly loaded.

It shows conclusively that tension exists in the top surface of the slab along the center lines between columns, thus confirming Mr. Arend's observations regarding the behavior of the floor finish in the building which he investigated. In the majority of flat-slab floors no provision is made for reinforcing the top of the slab in a direction normal to the center lines connecting columns, and to this lack of proper reinforcement may be attributed the cracks which Mr. Arend mentions as occurring in this region of the panel.

The experiments mentioned above indicated that a two-way system of reinforcement would be desirable as providing the most satisfactory method of meeting the stresses developed in flat-plate floors. It provides the necessary steel in the top of slab between columns and results in but two layers of bars in the top of slab over the column heads where maximum stress conditions exist. In the usual four-way system of reinforcement, the bars cross the column head in four layers so that the two layers are rendered largely ineffective through a shortened lever arm. To contribute further to the lack of efficiency of this reinforcement, it drops too rapidly towards the central portion of the slab, leaving a zone of concrete in tension unprotected by reinforcement, which accounts largely for the formation of circumferential cracks around the column in the top surface.

This condition is obviated in the two-way system by having the bars in but two layers over the column head and by extending them in the top of the slab past the line of contraflexure, thus giving the protection necessary against the formation of circumferential cracks.

W. S. THOMSON.
Chief Engineer, Corrugated Bar Co.
Mutual Life Building,
Buffalo, N. Y.
Mar. 7, 1913.

The Status of the Engineering Profession

Sir—In connection with the remarks on the status of the engineering profession in your issue of Jan. 3, I would like to relate an incident which came to my notice two weeks ago.

In the State of Wyoming, we have a State Engineer and also a Commissioner of Public Lands, both having charge of state departments. In handling applications for segregation of public lands for Carey Act irrigation projects, practically all of the matters concern the Commissioner of Public Lands. This being the case, it was thought it would be well to have an engineer, who should be a state official, with authority to examine and report on such applications, and then the state, when applying for a segregation, could have its own engineer certify to the feasibility of the project, and thus present the same to the Secretary of the Interior, backed up by the expert examination of a state's engineering official. On the other hand, if the project was inadvisable, the state could notify the original applicant and end the matter.

Several plans were suggested; first, that such an engineer should be appointed as an assistant to the State Engineer, and that then the whole matter of Carey Act segregations should be turned over to the State Engineer's office. Second, that a separate department should be organized under an engineer who would have charge of all Carey Act matters. Third, that an engineer assistant should be given to the State Land Commissioner, who should work under his direction upon Carey Act applications.

The Legislature is now in session and probably a bill for one of these measures will be brought before it. Several engineers were consulted as to which would be the best way to handle the matter. The whole crux of the question was this: How best to present this matter in the form of a bill, and how to word the bill so that the state should be sure of always getting a good engineer and a competent man?

Usually the qualifications for such a position as embodied in laws are about as follows:

> The . . . .. engineer, shall be a man who is practically and theoretically qualified to perform the duties of said office and shall be appointed by the Governor for the term of ..... years.

This, as you see, means nothing. Who is to be the judge of the qualifications? Very often politics have far more to do with the matter than competency. Then, if an incompetent man is appointed he is virtually saddled on the public for a term of years.

After carefully considering the matter, several of us concluded the best way would be to authorize the State Land Commissioner to appoint his own engineer assistant, and to fix the time of service to suit himself. This would give the State Land Commissioner the power to "hire and fire" his engineer at any time. This would also fix the responsibility for any delays in Carey Act matters directly upon the State Land Commissioner, and applicants would know exactly who was to blame. The State Land Commissioner could not shift responsibility upon an engineer appointed by the Governor, and whom the Commissioner could neither hurry nor remove.

Mr. Stillwell, in his address before the Institution of Consulting Engineers, referred to incompetent engineers,

and asked if in flagrant cases some method could not be devised whereby the responsibility could be placed where it belongs.

I would like to ask if some method could not be devised whereby the great engineering societies could not prevent a great deal of incompetency in public engineering positions, by helping to get the right men in the right place at first?

Mr. Stillwell also mentions the fact that for this and other situations of which engineers complain, they are themselves to blame, because of their retiring dispositions, and he is right.

To a great part of the public, one engineer is as competent as another. All that it is necessary to do is for a man to hang out a shingle "Civil Engineer," "Mining Engineer," and many men would employ him as quick as they would the president of a national engineering society.

This ignorance of the public as to the qualifications of an engineer is not confined to uneducated men either. I am personally acquainted with a bank president, a prominent judge, and another man who conducts a business of four or five million dollars a year. Each of these men would employ one engineer as quick as another. Yet each of these men are very careful to employ the very best lawyers they can obtain.

Such being the case, who can blame a Governor should he appoint an incompetent engineering official, or the public should they elect one?

Will a standardization of minimum fees to be charged by engineers help? I am very doubtful. It would probably do a great deal of good in such a place as New York, Chicago and other large cities; but it is a question if it would work in places of 100,000 or less. It would certainly help if the public knew that a good engineer, like a good lawyer or doctor, costs money; but they have first to be educated to this idea.

I know many engineers in the West who are called upon to testify in law suits, an employment which usually pays well; but they all agree that they are called because the lawyers in the case know the value of their testimony, and not the litigants themselves.

Engineers do not "butt into" things. Also they do not pull together. This is evidenced in the small engineering societies. Take the Salt Lake City engineering society, for instance. They have a nice society, whose members meet and read a paper or two, and possibly they have a little refreshment. Then they separate and forget about it until next time.

Now, in the City of Salt Lake, there are a good many engineers; but I do not know of one that has a large enough business to warrant his buying a multiplying machine, or a fine rolling planimeter, or a plane table, or a fine pantagraph, or an integrating machine. Each engineer has his own little library, his own little kit of instruments, which are, of course, ample for his usual work. When, however, a man who uses a transit almost entirely, runs up against a small plane-table survey, he has no instrument. If engineers pulled together, he could hire any one of these instruments from the society. There would not be enough work to warrant one engineer getting them, but there would be enough if they were available for the use of all. Then in small societies (and big ones, too), there is always a lot of reading and publication of papers, of which each will interest only a small number. The society should be thinking some of advancing the business interests of its members as well as of technical papers.

In order to do this, it should take an interest in seeing that engineering positions of every kind are well filled. Technical papers read at the meetings are extremely helpful; but we really derive more benefit from the man who gets us or gives us a job than we do from the finest paper ever written.

This, perhaps, looks sordid; but to come down to cold facts, I have yet to meet the engineer who is not hunting a job, with all the avidity that he hunted his first job after graduation.

If we could get our four great national engineering societies into a position where they would be called upon to recommend men for positions, and where their recommendations would be of weight, it would be a great thing.

The societies fight shy of this. Why? Possibly because they would not like to offend certain of their members. There is reason in this, too. But they could partially avoid this, if called upon to recommend men for a place by sending out the names of a dozen, two dozen or more men, considering availability in every respect, geographically and otherwise.

At the present time, consider what it means when a man writes after his name the cabalistic letters signifying his society membership. In the case of the four national societies, is this any guarantee whatever that he is an expert in his line? I am thankful to say that it usually means he is; but this is due more to the fact that the majority of the members are men of honor than the fact that they are members. I belonged to the American Institute of Mining Engineers as a full member when a student in college. This was good for me, but it certainly did not redound to the professional standing of the society. I know there are men belonging to the American Society of Civil Engineers who are rather below mediocrity. I presume the same thing exists in the other societies.

When one talks of a standard minimum price for engineering services it savors very much of trade unionism. We all know that one man is worth more than another. Trade unions get over this fact by saying that they only fix the minimum wage, and that as much more can be paid as the workman can get. The fact of the matter is that the minimum wage as fixed by the union almost invariably fixes the ruling price for labor. The same thing occurs to a great degree whenever a standard wage is fixed by tacit agreement. In Wyoming, it has become the custom to pay a U. S. Deputy Mineral Surveyor either $10 or $15 a day. It used to be $15 all around, but new men came in and cut the price to $10. Now only a very few of the old deputies with an established clientele can get $15. As there was more mineral surveying done than almost any other kind of surveying work, the above prices have gradually come to rule as the general price for engineering services. The result is that the beginner charges $10 a day, and many an experienced engineer, who can do twice as much work as the beginner, works for the same price. The plain reason for this is that the public is unable to differentiate as to the value of the service rendered by different men.

If the oldest and best deputies were to get together and set a minimum price of, say $25 a day, the result would

be that in general the public would choose to employ the men who would work for $10. Then also, we must remember that all kinds of work are not worth the same money. This fact is noted in the code of ethics of various societies, where the code makes a rather increased charge for services in court. It is certainly worth more to locate the line of a good sized irrigation canal, and to make the survey so that it will conform to all the laws and customs, than it is to run out lines and find section corners. Any ordinary surveyor, with a few months' experience, after leaving college, can do the latter (in ordinary cases) as well as the most experienced engineer, so the latter should not charge more for such work if he takes it than the new beginner would charge. In other words, "For like work, like pay."

Lawyers charge more per hour or per day for services in court than they do for drawing up an ordinary mortgage. And this is right. The idea of a minimum wage rate, however, is directly opposed to this idea. The minimum wage is essentially based on the time element alone. It says in effect that one man is as good as another, and one kind of work is as important as another, and, therefore, the pay per day should be the same. Is this the correct way to look at it?

To my above suggestion that the four great engineering societies should recommend engineers for positions, there is another very serious objection, and that is ignorance of the true qualifications of members. Take the American Society of Civil Egineers and note the requirements for admission to full membership. First, the endorsement of seven members is required; second, the applicant must have pursued engineering for ten years; third, he must have been in responsible charge of work for a certain number of years; fourth, he must submit a list of the work he has done, which must be approved.

The foregoing are the essentials, and are perfectly sufficient for membership. But are they sufficient for the Board of Direction of the Society to warrant its recommending the member for a certain piece of work? Probably the Board knows nothing personally of the member; they do not know how strenuously he may have worked for ten years; there is considerable latitude in responsibility; and there may be a good deal of elasticity in the list of work done.

Of course, there are members of all the societies whom the Board could recommend without question; but I refer to those members who have no national reputations and whom they would have to recommend. Suppose some small county in southern Utah decided to build a half dozen small highway bridges, and called upon the society to recommend an engineer for this purpose. It would be useless to recommend Wm. H. Burr, or Ralph Modjeski, or J. A. L. Waddell, or men of like caliber, because the work would be too small and the cost of the engineer would be out of all proportion to the probable cost of the structures.

Could the Board, however, recommend John Doe, of Provo, Utah, who had recently joined, and of whom the Board knew nothing more than his recommendations showed? A considerable responsibility would rest upon the members of the Board, and were I a member I would be loath to assume this, for a man whom I did not personally know.

I submit this letter to arouse discussion and trust that we will get the views of others on the subject.

W. NEWBROUGH.

Evanston, Wyo., Feb. 3, 1913.

[Since ENGINEERING NEWS has been foremost in urging the establishment of employment bureaus or appointment bureaus by engineering societies, it may be well to suggest how such bureaus should be conducted.

It would be manifestly impossible for the prominent engineers who usually constitute the governing body of an engineering society to give their personal time to the work of such a bureau, nor could such a bureau undertake to recommend a particular engineer for a particular appointment.

Such a bureau would naturally be managed by the Secretary or other salaried officer of the Society. The bureau would in the first place obtain from every member of the Society who was in any way open to an offer of a position (either a salaried place or an engagement as a consulting or designing engineer, or in any other capacity), a complete statement of his professional record in detail with a statement also as to the particular class of engineering work in which he was open to offers of a position or of employment in a consulting capacity. With this data there would be filed also a list of references with copies of letters of recommendation, testimonials, etc.

If, as our correspondent supposes, an application came into the bureau for an engineer to design a dozen small highway bridges for a county in Utah, those in charge of the bureau would select from the files the names of three or four or half a dozen engineers who were indicated in the classified list as competent and available for this particular class of work and who were located near enough to enable them to perform it economically. There would be transmitted to the applicant the names of these men with a complete copy of their professional experience, letters of recommendation, references, etc., as above stated. The county authorities applying could then undertake correspondence with the several engineers available and make their own selection from them with the aid of the information furnished by the employment bureau.

We make bold to say that only with the aid of some such complete record of a man's professional work, can *any* intelligent recommendation of an engineer for a particular piece of work be made. It is a common experience of every prominent engineer to receive letters requesting him to recommend an engineer for this, or that, or the other piece of work, or position. The engineer receiving such a letter runs over in his mind his list of personal acquaintances in the profession, and very likely recommends one of them for the place; but if he were cross-examined as to his positive and definite knowledge of some of the men whom he so recommends, it would develop in many cases that he was really rather hazy as to just what the man had done longer ago than two or three years perhaps.

There are engineers who, by some lucky stroke which has brought them into public notice, find plenty of important work coming their way. There are other engineers who have had long and valuable experience in responsible work, but which has attracted little or no public attention. Such men, when some change of fortune

obliges them to seek new engagements, find their past experience rated at nothing like its proper value.

It may be said that if such a bureau were conducted in a similar manner to the private employment bureaus, as the above suggestion may seem to indicate, this work should be left to private enterprise instead of taken up by the engineering societies. The answer to this is that an engineering society could so conduct such a bureau that no loss of prestige whatever would result to an engineer registering in it.

Here is the opportunity for the leaders of the profession to be of great service to their less fortunate brothers. The mere fact that such a bureau had the great men in the profession registered in its records as available for consultation and appointment would give the bureau a character and standing and reputation that cannot possibly be attained by any employment bureau carried on as a private business.

It may be well to say further that there is no reason why such work as we have outlined above should be confined to the national societies. State engineering societies and the local organizations of engineers in the smaller cities have an equal opportunity to engage in such work for the benefit of their members. And not alone for the benefit of their members, but for the public benefit. For there is probably no greater service which an engineering society, either national or local, can render for the public welfare than by providing means whereby engineers of thorough competence can be placed in the positions demanding responsibility.—ED.]

NOTES AND QUERIES

The description of the construction of the footway tunnel at 191st St. and Broadway, New York City ("Engineering News," Mar. 6, 1913, p. 484) omitted to state that the engineer in charge of construction was R. A. MacGregor, Assistant Engineer, Bureau of Highways, and that the line and grade work was done by A. E. and G. C. Wheeler, City Surveyors. The tunnel was not entirely in rock, as stated in the article, but was built for the 200 ft. nearest to Broadway by cut-and-cover work in earth. We are informed that the leakage into the tunnel has been steadily decreasing since its completion.

Several correspondents have noted an apparent error in the stated number of typhoid germs used in anti-typhoid inoculation on one of the U. S. Reclamation projects, as given in the letter by W. S. Merrill in our issue of Feb. 20, 1913. Mr. Merrill appears to have accidentally omitted three ciphers from his figures, since in the general article on U. S. Reclamation Service practice by Dr. Hugh A. Brown, in our issue of Mar. 13, 1913, the first inoculation is given as 500 million and the second and third as one billion each. The large dosage, we understand, is the one commonly employed in other services as well.

❖

Annual Meeting of the Highway Engineers Association of Missouri

In Missouri, as in most of the central states, there is an immense mileage of roads which (during the mud season) are roads in name only, while the engineering and administrative problems of obtaining a system of good roads are only in the early stages of their solution. Missouri, however, has a state highway department and a state highway engineer, whose duties are mainly educational. It has also adopted the system of having county highway engineers; but not every country has such an official as yet, and in such cases the duties come within the jurisdiction of the county surveyor.

The sixth annual meeting of the Highway Engineers Association of Missouri was held at the Planters Hotel, St. Louis, Mo., on March 5 and 6, with a fair attendance. The President, J. M. Stallard (St. Joseph), was in the chair. In an opening address, the State Highway Engineer (Curtis Hill) laid particular stress upon the questions of maintenance and repair, pointing out that there is altogether too little of the former and too much of the latter. Maintenance means keeping a road in proper condition, while repair means restoring a damaged road to the condition in which it should have been kept. Maintenance is absolutely essential in the case of earth roads.

The subject of road legislation received attention, and a committee on legislation was proposed, to give proper bills the support of the association. This was opposed by Mr. Hill, on the ground that the bills are continually liable to radical changes introduced for political purposes, so that the indorsement might apply to bills having objectionable features. Main roads crossing the state and connecting county towns were advocated by S. J. Roy (Hannibal). He suggested a bond issue of $10,000,000 for roads, but pointed out that to secure this it would be necessary for the engineer to prove that it would be a good investment. In any system of taxation for roads, the cities should be included, and not exempted, since they benefit as well as the rural districts.

Roy Britton, President of the Missouri State Highway Commission, spoke in favor of state aid, but considered that such aid should be mainly educational and promotional, and should not apply to road construction by the state. The work of the State Highway Engineer also should be largely of an educational character; all locations and plans for roads should be subject to his approval, and all designs for bridges and structures should also require his examination and approval, but he should not undertake to prepare such plans or designs. The county highway engineers should be in direct charge of the execution of the work. Local effort is a fundamental requirement for road improvement; and the state should not undertake to initiate work where there is no such effort. One bill now before the legislature provides that the state shall pay $2000 for dragging the roads provided that the county raises $2000 and the landowners along the road also raise $2000; no piece of work to be less than five miles in length. A resolution was adopted requesting the governor to have the engineering profession represented on the proposed public service commission.

A paper on "Concrete Highway Bridges" was presented by D. B. Luten (Indianapolis, Ind.); this dealt not only with questions of design, but also with those of patent rights, and of the unfortunate tendency to put construction in the hands of inexperienced men. This last is due largely to the letting of contracts by lump sums, and he submitted a form of detailed estimate which would tend to check this condition. He did not approve of the engineer submitting detailed plans, and then passing upon his own plans as well as those submitted in competition. The engineer should prepare general plans and complete specifications, and the bidders should submit detailed plans conforming to the requirements. In this way the several designs would be

comparable, which is not the case when bidders submit their own plans in competition with those of the engineer for the work. Two other papers on bridge work were read by title; "Steel, Concrete and Wood Bridges," F. J. Kersting; "Progress in Design and Construction of Highway Bridges," F. D. Hughes. Other papers (also read by title) were: "The County Surveyor," Alfred Riske; "The County Highway Department, and the Relations Between the County Court and the County Highway Engineer," L. M. Stallard; "Streets and Pavements in St. Louis," Walter Hempelmann. On one evening the members attended a meeting of the Associated Engineering Societies of St. Louis, when a paper on city planning as related to the development of the city of St. Louis was read by Mr. Gundlach, President of the City Council.

The officers for 1913 are as follows: President, Alfred Riske, County Surveyor and Highway Engineer, St. Charles, Mo.; Vice-President, R. C. Allen, Clinton, Mo.; C. Cargill, St. Joseph, Mo. The next meeting will be held at St. Joseph.

Flooding of Sewage Pumps at Batavia, N. Y.

A few weeks ago the sewage pumps of Batavia, N. Y., were stopped for a short time as a result of high water. We are indebted to K. B. Mathes, chairman of the Sewer Commission and to Robert L. Fox, city engineer, for the following account of the difficulty and the way it was met:

The sewage pumping station is 32 ft. in diameter and about 27 ft. in depth. Its bottom is divided into six compartments. In two of these there are two 1050-gal. per min. submerged, vertical, centrifugal pumps and in a third compartment there is a similar pump with a capacity of 470 gal. per min. The shafts pass upwards, with the runner supported on a ball-bearing step. This step is about 12 ft. above the bottom of the pumps and 2 ft. above the top of inlet sewer.

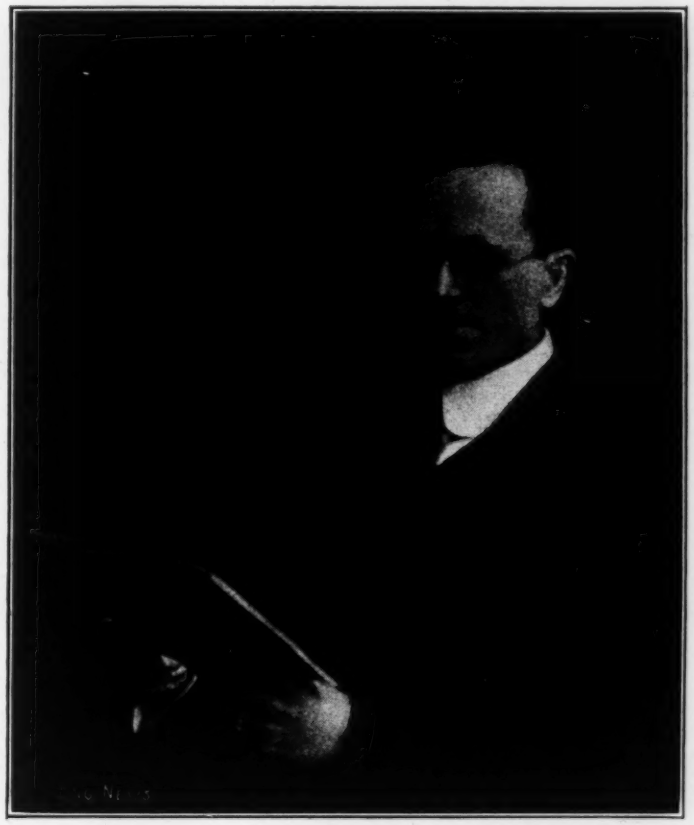
At the time of the trouble one of the large pumps had been taken apart for an examination. About this time a thaw accompanied with rain caused the Tonawanda Creek to overflow its banks and to cover certain outlying and low streets. Elsewhere certain streets were covered with storm water due to the inefficiency of the old storm water system. The result was that this water naturally ran through the perforated manhole tops of the sewers in several places. Certain cellars of houses along the shallow creek commenced to fill with water seeping through the walls. The occupants opened up their cellar drains and sewers. From these various causes the pump well soon received all the water that the two pumps could handle.

About this time a faulty ball bearing on the second pump broke, leaving the small one to take care of the flow. Before the ball bearing could be repaired the plant became flooded, forcing the machinists out of the well. The sewage being to a certain extent gritty, very soon got into the bearing of Pump 3 and caused the bearings to break, thus forcing a complete stoppage of pumping.

Within 24 hours a temporary steam-driven centrifugal pump of 1050 gal. per min. capacity was installed at a manhole outside of the pump station and one of the regular pumps was jacked up and run on split collars, fastened on the pump shaft and resting on a journal box in the basement. Within forty minutes after these two pumps commenced to run the sewage was lowered and new balls inserted in the raceways of the bearings of Pump 3. Then Pump 2, which had been running on split collars resting on a journal box, was repaired. Within two hours the pump station was running the same as usual, the two pumps handling the entire flow. The fact that the creek had receded only a few feet, enough to prevent surface water from entering the manhole tops, is indicative that the capacity of the pumping station is ample, excepting in an extreme case of the river flooding the low streets, as has been described.

Edwin F. Wendt: President, American Railway Engineering Association

Edwin Frederick Wendt, Assistant Engineer of the Pittsburgh & Lake Erie R.R. (New York Central Lines) was elected President of the American Railway Engineering Association at the annual meeting held in Chicago, Mar. 18-20. He was educated in the public schools of New Brighton, Pa., and in 1888 he graduated from Geneva College, Beaver Falls, Penn., with highest hon-



EDWIN F. WENDT, PRESIDENT OF THE AMERICAN RAILWAY ENGINEERING ASSOCIATION
(Assistant Engineer, Pittsburgh & Lake Erie R.R.)

ors in the classical course. He has been a member of the Board of Trustees of that institution since 1907.

He entered railway service in 1888 as axman and chainman in the engineering corps of the Pittsburgh & Lake Erie R.R., and rose through the positions of rodman, levelman and transitman. In October, 1898, he became Assistant Engineer in charge of maintenance-of-way and construction and contract work. Since he has

held that position extensive improvements have been made, the road extended and reconstructed, and widened for additional main tracks, extensive yards and shops have been built, and the new terminal station and office building at Pittsburgh, while the entire road has been equipped with automatic block signals and interlocking plants. Mr. Wendt is a charter member of the American Railway Engineering Association, has served on many of its committees and has been Vice-President and a member of the Board of Direction. He is a member also of the American Society of Civil Engineers and the Engineers' Society of Western Pennsylvania.

Tests on Cast-in-place Concrete Piles

By Francis L. Pruyn*

Owing to some very unfortunate experiences with cast-in-place concrete piles, the writer started out in search of a concrete pile which, if possible, could be relied upon at all times and places, or in other words, would be as nearly fool-proof as possible. He was perfectly familiar with the distortion that takes place with cast-in-place piles when they are driven in succession on close centers, such conditions as were disclosed in Engineering News, Sept. 12, 1912, and Feb. 27, 1913, and

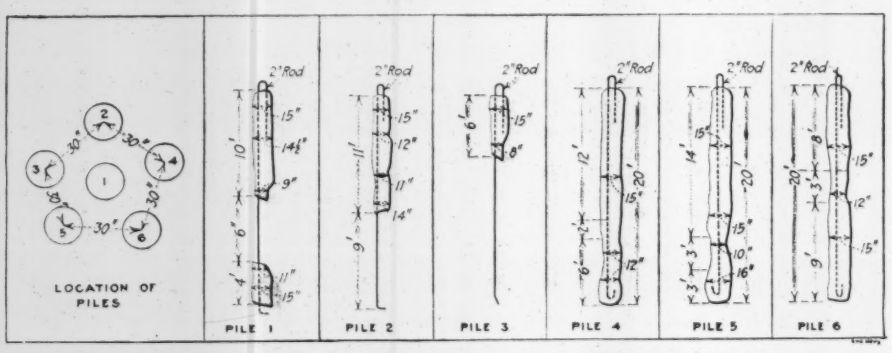


Fig. 1. Cast-in-place Concrete Piles Three Weeks after Driving on 30-in. Centers

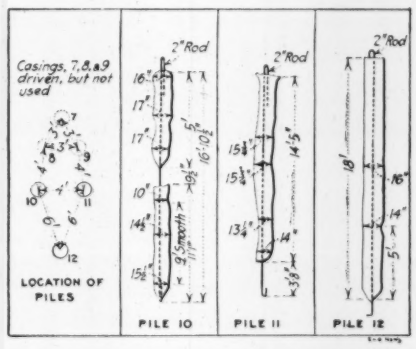


Fig. 2. Cast-in place Concrete Piles Three Weeks after Driving on 4-ft. and 6-ft. Centers

was of the opinion that this distortion was caused by the movement in each stratum of the soil as it was punctured and displaced laterally by the forming apparatus for the adjacent pile. He felt that if a freshly cast pile could be protected during this driving process, a perfect cast-in-place pile would be the result. It was to prove this theory the following tests were made and no one was more surprised and disappointed than the writer when his carefully conceived theory did not work out in practice.

The tests prove conclusively that in the driving of piles by the displacement method a heavy pressure is set up in the surrounding earth, that the deeper the penetration the heavier this pressure is likely to be, and that this pressure is not immediately dissipated through the surrounding earth, but remains, for a period of 24 hours at least, an active force, intent on crowding back into its original position as soon as the restraining element is removed.

Two tests were made—one consisting of a group of six piles driven on 30-in. centers, and the other consisting of a group of piles with varying distances between centers of 3, 4 and 6 ft.

*Vice-president, The Underpinning & Foundation Co., 290 Broadway, New York City.

Test No. 1 was made by driving six 16-in. diameter steel shells, 20 ft. long, one at a time, into the ground by means of a steel core fitting tightly therein; in other words, by the displacement method. The day after all the six steel shells were driven in the numerical order shown they were concreted one at a time (also in the order shown) and the casings pulled. A 2-in. rod was left in the concrete piles so that after they had seasoned they could be pulled out of the ground and examined. This was done about three weeks after the piles were driven. The concrete was of a 1:2:3 mixture. The results of the tests are shown in the accompanying diagram (Fig. 1).

It will be noted in one case that the 2-in. steel rod was straightened out so that the pile slipped off the end of the rod, and that in other cases, the lower part of the pile was missing, while the hook on the bottom of the rod remained intact. It is very evident that three weeks is not sufficient time to set up the point of some of these piles, a condition probably brought about by the admixture of sand and mud with the concrete and caused by the pressure of the earth on the wet concrete as soon as the shell was removed.

After the very unexpected failure of these piles on 30-in. centers, a second group was driven (Fig. 2). The three piles driven on 3-ft. centers were never concreted, but Nos. 10, 11 and 12 were finished and later pulled out and examined. All the shells, however, in this group were driven and remained in place until after Nos. 10, 11 and 12 were concreted and their shells withdrawn.

These piles on 4-ft. centers showed about the same deformation as those on 30-in. centers, while the one on 6-ft. centers showed an almost perfect pile, proving that at long distances between piles, the earth pressures are not transmitted.

The test was made in Long Island City, several blocks south of the Queensborough Bridge. The ground was soft water-bearing loam and sand, or a good average of the materials met with in ordinary practice.

In Test 1, the inside pile was driven first, and the outside piles were the last ones driven. Considerable difficulty was met with in driving the last piles on account of the compacting of the material through the driving of the other piles.

It is evident that there has developed a heavy compression in the soil through which the pile is driven, and that this compression is not dissipated in the surrounding material, but is always present to squeeze the soft

concrete out of position as soon as the protecting shells are withdrawn. If this is true in the case of the piles driven on 4-ft. centers, it is very remarkable, and demonstrates quite clearly that under the majority of conditions met in practice this type of pile is not reliable.

Great care was used in driving the piles and filling them, as well as in the mixing of the concrete. A very rich mixture of concrete was used, and everything was done in the hope that a perfect pile could be formed by this method.

The Improvement of the Cuyahoga River at Cleveland, Ohio

There has been agitation for a number of years at Cleveland for the straightening of the Cuyahoga River as an inner development of the lake harbor there. A survey of the river was authorized by Congress in February, 1911, and a detailed study with an estimate of the cost of possible improvements was made by Col. John Millis, U. S. A., in charge of the Cleveland district. To provide a definite starting point for discussion and negotiation, Gen. W. H. Bixby, Chief of Engineers, U. S. A., suggested that a city commission be appointed and authorized to report on the various questions relating to the improvement of the lake front and river. In June, 1911, the city council authorized such a commission and the mayor appointed as the five members J. H. Cassidy, E. S. Griffiths, H. C. Gahn, W. P. Rice and Augustus Mordecai. The commission immediately organized and began its discussions with city officials, government engineers, state authorities, civic organizations, property owners, railroads, steamship lines and other carriers. It also visited numerous lake and Atlantic ports.

No appropriation was given for detailed engineering studies, but plans and surveys of the federal and city engineers were at the board's disposal. In January of this year the commission made its report—outlining in rather broad fashion the most feasible projects. These are outlined below as disclosed by this report.

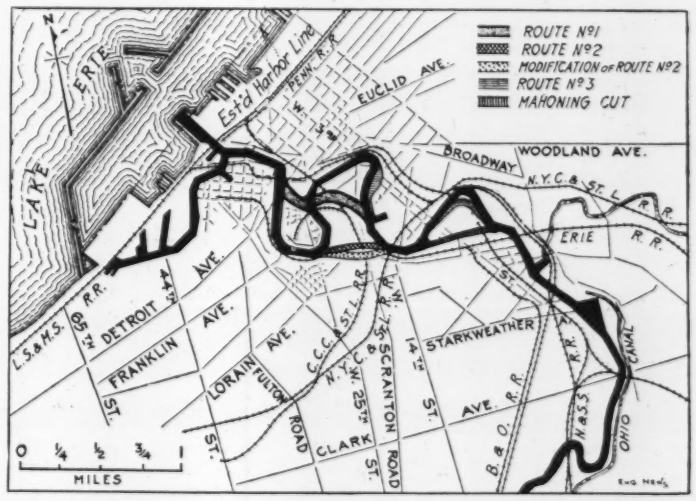
Present Conditions—In the city of Cleveland and for 10½ miles south from its mouth the Cuyahoga River runs through a flat valley, from 80 to 100 ft. deep and from 3000 to 5500 ft. wide, in a level plateau bordering the lake; the approach to this valley is steep. The flats are of clay and sand. From the Superior Ave. viaduct (see accompanying figure) to the Erie R.R. bridge, the flats are some 300 ft. wide between the side hills. The river channel is very crooked, crossing the valley four times. From the Erie R.R. bridge to Thornburgh, 10½ miles from the mouth, the flats are irregular, but the channel is straighter, though there are several short and sharp bends which must be corrected. Thornburgh is considered the economic head of river navigation.

Between the Superior Ave. viaduct and the Erie bridge it is 7900 ft. in a straight line, but 17,420 ft. by the river; the area of the adjacent flats is 686 acres. From the Erie bridge to Thornburgh it is 41,406 ft. in a straight line, but 54,582 ft. by the river. The area of adjacent flats here is 3946 acres, of which only 541 acres are now used for manufacturing.

The present navigable channel extends 5.2 miles from the mouth of the river. Above this point no improvements have been made, but the work contemplated includes straightening and deepening the channel and building docks along the river for about 8000 ft. farther up the stream to a point near the Harvard-Denison St. bridge. Here a new connection can be made with the Ohio canal which is being improved by the state. This canal connects near Zanesville with the Muskingum River on which the federal government maintains eleven locks, so that there is a possibility of a through waterway from Lake Erie to the Ohio River at Marietta. In the short stretch of the Cuyahoga River, where improvement is contemplated, there are 24 bridges, nine of which have draw-spans and 13 of which carry railway tracks.

The commission reports that the improvement of the flats above the Erie bridge would permit of an industrial development represented by the expenditure of $50,000,000 in manufacturing plants and the creation of river traffic amounting to 20,000,000 tons per year, largely having to do with the reduction of iron ore. It is on account of this possible development that the commission justifies the proposed expenditures for river development and even states that the waterway must be improved as suggested if the city is to maintain its important position and encourage the development of local industries.

Before 1890, boats of 200 to 300 ft. in length, drawing



Map of Cleveland, Showing Proposed Improvements of the Cuyahoga River

15 and 16 ft. of water, were considered large in this district, but now the committee finds that 50% of the traffic is carried in boats 500 ft. or more in length, drawing 19 ft. of water. Some boats are 600 ft. long and two new ones are 617 ft. None of these 600-ft. boats can get through the Cuyahoga River where improvement is contemplated, although a channel depth of 21 ft. is maintained by the city.

In July, 1912, the commission favorably reported on the improvement of the upper valley by cutting a new channel in the middle of the low land to open up 3½ miles of river frontage above. The plan has been approved by federal and city engineers and the preliminary steps are under way. For the fullest use of this development, however, the commission finds that the lower-river improvements discussed in their recent report are necessary.

Proposed Changes—These latest plans are aimed to make the river as straight as necessary and with reasonable cost and least possible interference with present occupants of the flats (lumber yards, planing mills, miscellaneous industries, railroad tracks and terminals). The

commission admits that a considerable readjustment of the holdings in this territory will be required but holds that the lumber interests can be shifted with less harm than can the railroads and that the minor industries involved do not require the use of water fronts. They have found no plans of improvement which can be developed without the opposition of all parties adversely affected. The attempt of the commission has been to lay out plans which would interfere as little as possible with the large plants where ore is transshipped and with the main tracks of railroads.

There are three projects under consideration, one of which (No 3. in accompanying figure) is but the widening and deepening of the present channel, resulting in a route of 17,420 ft. The route most favored by the commission is 9555 ft. long and the second one, 10,340 ft.

Plan No. 1 involves the relocation of the channel beginning at a point 400 ft. south of the Superior Ave viaduct, and intersecting the old channel between the C. C. C. & St. L. Ry. freight bridge and the same railroad's passenger bridge, and also opposite Central Ave. This route meets with the least objections from the railroads, is most central regarding the flat lands and best calculated to serve them. It has advantages over the second route in that immediate relief can be afforded by completion of the first cut, while the balance of the river improvement is being completed; this first benefit can be secured by an expenditure of about one-quarter the total including the Mahoning Ave. cut which is a desirable part of the work.

This project conflicts somewhat with the new high-level bridge which is being built. On account of the relocation of the channel, the new bridge will offer only 80 ft. of clearance over the water (compared with 93 ft. over the old channel), which is less than the required height of the rear-light mast on some freight vessels. The commission holds, however, that there has been no serious objection offered to the use of adjustable masts for passing this point.

The estimates presented for the cost of the three routes are given in the commission's report as follows:

Route No. 1 exclusive of Mahoning cut	$3,100,000
Route No. 2 inclusive in Mahoning cut	3,300,000
Route No. 3 exclusive of Mahoning cut	3,854,000
Mahoning cut	1,700,000
Route No. 3 carried above proposed Mahoning cut	4,455,000

The above estimates for Routes 1 and 2 are given by the U. S. District Engineer's office, and No. 3 by the City Engineer. While No. 3 is not a radical proposition and does not appreciably shorten the distance to the upper river, there is shown no decided economy in it on account of the great cost of bulkhead construction and land condemnation.

Different interests and persons have proposed various substitute routes, the best of which shown, according to the commission, is a modification of route No. 2, which avoids some of the complications and disturbances to industries incident to route No. 2. It would make necessary the leveling off of a large portion of the southern hills to the lower level. This would increase the land available for manufacturing purposes; the railroad situation, however, would not be improved.

As compensation to the railroads for damage suffered by Plan 1, the commission suggests consideration of a plan to fill in Collision Bend with excavated materials to carry West 3rd St. across the fill on a low viaduct, thus doing away with the maintenance of two city drawbridges, and allow the Erie R.R. to replace its lost track facilities by extending to the made land. The C. C. C. & St. L. R. R. would be relieved of the care and maintenance of an extra bridge at Carter Road by filling up the old channel between the present bridge and Collision Bend, though this would necessitate shifting the lumber interests to another locality.

FINANCING—The commission points out that, on account of the relation of this work to the outer harbor of the city, to the Ohio canal being enlarged by the state, and to the improvement of the Muskingum River by the federal government, a wide community of interests is shown. The commission recommends that the city should assure the federal government of its willingness and ability to bear 50% of the cost of this river improvement, and that this cost be directly apportioned on the interests benefited.

❖

Tornadoes in the Lower Mississippi and Gulf States, on Mar. 12, caused the loss of a hundred or more lives and extensive property damage.

Panic in a Moving-picture Theater, at Vervius, France, on Mar. 9, resulted in 10 deaths and injury to 45 others among the audience. The fire was insignificant and was quickly extinguished without damage to persons or property.

An Explosion of Natural Gas wrecked two buildings and caused injury to 13 of their occupants on Mar. 7, at Hot Springs, Ark. The gas had collected in the basement of one of the buildings.

A Dynamite Explosion at Arder, Scotland, on Mar. 10 destroyed the works of the Nobel Explosive Co., killing six and injuring 10 persons, and wrecking buildings in Arder and the adjacent village of Irvine. The scene of the accident is about 20 miles from Glasgow.

The Wright Aëroplane Patents were upheld in a decision of the French Court of Appeals, rendered Mar. 13. The principal claims made were relative to alleged infringements of the warping wing effect as in the American and German proceedings in which the courts concerned have recently given verdicts upholding the Wright patents.

A New Altitude Record for aëroplanes was established in the vicinity of Paris, on Mar. 11, when a French aviator, using a monoplane, reached a height of 6000 meters (about 19,600 ft., or close to 3¾ miles). The previous record was 5450 meters (17,900 ft.) made at Villacoublay, Sept. 17, 1912, by another Frenchman, Legagneux.

A New Building at Washington for the U. S. Geological Survey, Reclamation Service, Indian Office and Bureau of Mines, was provided for by an act of the last Congress. The building is to occupy the entire block bounded by 18th, 19th, E and F Sts., N. W., and is to cost approximately $3,000,000 The design will be started immediately.

The Formation of Union Water Districts in New York by agreement between municipalities and the construction of water-supply works for such districts by the State Conservation Commission is authorized by Assembly Bill 1147, now before the legislature. The works would be paid for by the water districts.

The New Capital City of Australia is to be named Canberra, after the district where it is to be located. The foundation stone of the capital building was laid with appropriate ceremonies on Mar. 12, 1913. The governmental commission appointed for the purpose has made a plan for the city based on the numerous plans submitted in the recent competition, but the formal adoption of this official plan has not yet taken place.

Company Stores for supplying employees with meat and groceries at cost price, are contemplated on a large scale by the Interborough Rapid Transit Co. and the New York City Railways Co., and the first of these stores was opened on Mar. 13 and did an unexpected volume of business. The stores are only open to employees of the two allied companies or members of their families. Goods are sold at cost price, the expense of running the store being borne by the company. Sales are made on a strictly cash basis and no deliveries are made. The use of currency rather than company slips makes it entirely optional with the employee as to whether or not he will use the service.

Two Large Diesel Oil Engines have been purchased by Phelps, Dodge & Co., of New York City, for an electric power plant at one of its Arizona mines. The engines have been ordered from Carels Bros., of Ghent, Belgium, and are 2-stroke cycle, 4-cylinder machines to be direct-connected to 60-cycle alternators. The engines are guaranteed to each deliver 1000 hp. when operating at an elevation of 6500 ft. above sea level with a fuel consumption not exceeding 0.48 lb. oil per b.hp.-hr. The two alternators are to be operated in parallel. These are the first 2-stroke cycle Diesel engines to be sold in the United States. In Europe, however, the 2-stroke cycle Diesel engine is in very extensive use.

Commerce Passing Through the Duluth-Superior Harbor during the calendar year 1912, showed an increase of 35.22% over the tonnage of the previous year. Of this increase hard coal, soft coal, wheat and other grains, iron ore, flour, lumber and oils, all show an increase in both quantity and valuation, while general merchandise shows a decrease. The total valuation of the receipts in the harbor is $89,661,073, and the total value of the shipment is $231,260,859, making a total of $320,921,932. The harbor was open only 235 days, so considering the mean monthly freight movement during the season of navigation, Duluth-Superior Harbor practically stands next to New York. In a value of total shipment and receipts the past year was the greatest in the history of the harbor.

A Contract for Electrical Energy for use in constructing the Sun River Irrigation Project has been made by the U. S. Reclamation with the Great Falls Power Co., of Montana. The contract is for six years and calls for 2500 kw. of power. The company will transmit the power one hundred miles to a number of substations, from which it will be distributed for use on the work. The Service states that the use of electrical energy for canal excavation is new and will reduce the time and cost of the work. Proposals for excavating the main canal, 45 miles long, will soon be invited. The diversion dam, 140 ft. high, and the diversion tunnel will be built by Government forces.

The Third International Congress of Refrigeration will be held at Chicago, Ill., on Sept. 17-24, inclusive, at which time the industrial applications and engineering problems of refrigeration will be discussed jointly by American and foreign specialists in that line. The program is being arranged for six parallel sections, so that the desired ground can be covered in the limited time available.

New York City will be a rendezvous for the foreign delegates, during the week preceding Sept. 14, on which date they will proceed to Washington, D. C., where the Congress will be formally opened on Sept. 15. The Chicago program starts on Sept. 17. The Congress sessions will be held in the forenoon each day, leaving the afternoon and evening open for excursions and entertainment features. Papers for the Congress should be in the hands of the Section Committee before May 1. Regular membership is secured on the payment of a fee of $4. The Secretary is J. F. Nickerson, 431 S. Dearborn St., Chicago.

The International Engineering Congress, to be held at San Francisco in September, 1915, in connection with the San Francisco Exposition, is being organized by delegates appointed by the five national engineering societies and selected from members resident on the Pacific Coast with the president and secretary of each society as ex officio members. Those appointed by each society are as follows:

The American Society of Civil Engineers—A. L. Adams; C. D. Marx; W. A. Cattell; C. Derleth, Jr.; the president, Geo. F. Swain; the secretary, Chas. Warren Hunt.

The American Institute of Electrical Engineers—A. M. Hunt; Calvert Townley; the president, Ralph D. Mershon; the secretary, F. L. Hutchinson.

The American Society of Mechanical Engineers—W. F. Durand; R. S. Moore; T. W. Ransom; C. R. Weymouth; the president, W. F. M. Goss; the secretary, Calvin W. Rice.

The American Institute of Mining Engineers—E. H. Benjamin; H. F. Bain; W. S. Noyes; Newton Cleaveland; the president, C. F. Rand; the secretary, Bradley Stoughton.

The Society of Naval Architects and Marine Engineers—G. W. Dickie; W. R. Eckart; W. G. Dodd; J. V. Paterson; the president, R. M. Thompson; the secretary, D. H. Cox.

Hydro-electric Companies transmitting current across state boundaries are made subject to the Interstate Commerce law by a clause in the River and Harbor appropriation bill as passed by the Senate on Feb. 25. The clause is as follows:

That the provisions of the Act entitled "An Act to regulate commerce," passed and approved Feb. 4, 1887, together with the amendments thereto, shall apply to any corporation or any person or persons engaged in transmitting hydro-electric power or electricity from one State, Territory, or District of the United States to any State, Territory, or District of the United States, or from one place in a Territory to another place in the same Territory or to any foreign country, and that the term "common carrier" as used in said Act and the amendments thereto shall include companies engaged in transmitting hydro-electric power or electricity as aforesaid: Provided, That said Act shall not apply to the transmission of hydro-electric power or electricity wholly within one State and not transmitted to or from a foreign country, from or to any State or Territory as aforesaid; that the rules prescribed in said Act as to just and reasonable charges or rates and the procedure relative to other common carriers, in so far as applicable, shall apply to such company, person, or persons transmitting hydro-electric power or electricity as aforesaid, and to the fixing and establishing of just and reasonable charges or rates fully and completely.

A Six-months' Safety Campaign in the public schools of the Borough of Brooklyn has been recently announced by the Brooklyn Rapid Transit Co., in conjunction with the American Museum of Safety, which has done similar work in Manhattan for some time. Lectures are to be given in all the schools, illustrated by models and lantern slides, and pamphlets and buttons will be distributed to arouse interest.

The Diversion of Water from Lake Michigan for the Chicago drainage canal is claimed to be an inherent right, not subject to the approval of the Federal Government; according to the latest position taken by the Sanitary District of Chicago. The decision rendered by the (then) Secretary of War on Jan. 8, denying the application of the District for permission to increase the present rate of diversion, was not accepted as final, and in fact a proposition for the withdrawal of the application was made a few days before the decision was rendered, as noted in our issue of Feb. 6. The application was made originally in February, 1912. The reason for this proposed withdrawal was the assumption that no such permission for the Secretary of War is necessary to enable the Sanitary District to take such water as is required for the purposes of the canal (as a drainage channel and as part of a deep waterway) there being inherent rights to the water, and the canal having been built without objection on the part of the Federal Government, while the diversion of water has been neither authorized nor prohibited by Congress. A review of the case and of the issues involved has been prepared by Lyman E. Cooley, the present consulting engineer for the District, and has been issued in book form. It denies that the desired increased flow in the canal will have serious effects upon the lake levels, and that in any case the advantages will be so much greater than any damage caused that the conditions will call for remedial works (which can be carried out without difficulty) and not for the restriction of water-supply to the canal. The preface states:

While the Sanitary District has always taken the position that it had the right to divert or flow through its canal sufficient of the waters of Lake Michigan to take care of the needs of the inhabitants of the District, yet, in view of the blending or close relations of the State and Federal governments in such matters, the District has so far sought to obtain the acquiescence of the Secretary of War with respect to the amount of the flow of water.

Sewage Pollution of Lake Erie with Relation to City Water-Supplies was the subject of a conference held at Cleveland, Ohio, on Mar. 4, 1913, between a committee of the members and staff of the Ohio State Board of Health and representatives of the cities of Cleveland, Toledo, Sandusky, Lorain and Lakewood. The State was represented by John W. Hill, of Cincinnati, and Wm. T. Miller, Cleveland, members of the State Board of Health, and W. H. Dittoe, Chief Engineer, and Dr. Thomas R. Brown, bacteriologist of the Board. We are indebted to Mr. Dittoe for the following summary of the main points brought out by the discussion at this conference:

(1) Untreated sewage emptied into Lake Erie directly and into tributary streams at points near their mouths and the discharge of tributary streams receiving sewage from inland points contribute to local pollution and possibly to general pollution of Lake Erie.

(2) It is probable that no general pollution of Lake Erie exists and that the pollution, if any, is confined to zones within limited distances of the cities and mouths of rivers contributing sewage.

(3) It is probable that the sewage from any particular city has a more detrimental effect upon its own water-supply, if taken from the lake, than upon the water-supply of any other city taken from the lake.

(4) The problems involved should be consideed as primarily local and in general the solution in any particular case will probably be the carrying out of a plan for the protection of the city making the improvement.

(5) The water-supplies taken from Lake Erie at limited distances from the shore should be purified.

(6) In the absence of any extensive data relative to the general quality of the water of Lake Erie and the effect of sewage discharged therein, it is advisable that the degree and extent of the pollution of the lake be investigated.

A resolution was adopted declaring it to be the sense of the meeting that an investigation of the degree and extent of the pollution of Lake Erie caused by sewage from Ohio municipalities should be carried on by the State Board of Health and the municipalities coöperatively. A resolution was also adopted providing for the appointment of a committee to fix standard methods of analysis of samples and the nature of the determinations to be made in the investigation. The committee appointed for this purpose was composed of Dr. Brown, Dr. Roger G. Perkins, bacteriologist, Cleveland Board of Health, and Dr. Paul E. Bethards, bacteriologist, Toledo Board of Health.

A Station for the U. S. Bureau of Mines, to cost $500,000, is provided by an appropriation in the recent act of Congress for the erection of new public buildings, etc., approved March 4. The work of the Bureau is now scattered in different parts of the country and its experiment station is in Pittsburgh. The station is located on property of the U. S. War Department, which now needs the space for its own work, and has ordered the Bureau to move. The station buildings originally proposed were: (1) Engineering Building, 500x200 ft., three stories, to cost $100,000; (2) mine-rescue building, 50x100 ft., 2½ stories, $40,000; (3) chemical building, 50x200 ft., three stories, $100,000; (4) explosives building, 50x80 ft., 2½ stories, $30,000; (5) mechanical building, 50x150 ft., three stories, $75,000; (6) fuels building, 50x150 ft., $55,000; (7) service building, 60x100 ft., $60,000; tunnels, pipe lines, etc., $20,000; sidings, storage bins, etc., $20,000. Dr. J. A. Holmes, in commenting on his request for the appropriation, noted that suitable buildings for this special work cannot be rented and that it is necessary to build new. The cheapest construction permissible with dignified appearance is planned. The site offered, in exchange for a part of the present U. S. Arsenal ground (13¼ acres), is what is known as the Magee High School site, on Forbes St., and along the Baltimore & Ohio R.R. It contains 11½ acres.

PERSONALS

Mr. James McCrea, former President of the Pennsylvania R.R., is seriously ill at his home in Haverford, Penn.

Dr. S. W. Stratton, Director of the U. S. Bureau of Standards, Washington, D. C., has been elected a member of the council of the Underwriters' Laboratories, Chicago, Ill.

Mr. Theodore N. Vail, President of the American Telephone & Telegraph Co., has been elected a life member of the corporation of the Massachusetts Institute of Technology.

Mr. R. C. Wise, formerly Mechanical Engineer of Henion & Hubbell, Chicago, Ill., has been elected Secretary of the Western Pump & Engineering Co., 339 Railway Exchange, Chicago.

Mr. G. A. Law, formerly Trainmaster of the Chicago, Burlington & Quincy R.R., at Aurora, Ill., has been promoted to be Superintendent of the Hannibal division, with office at St. Louis, Mo.

Mr. J. E. Bond, formerly Chief Engineer of the B. M. Osbun Co., Chicago, Ill., has been elected President and Treasurer of the Western Pump & Engineering Co., 339 Railway Exchange, Chicago.

Mr. George W. Greene has been appointed Resident Manager of Morgan T. Jones & Co., Inspecting and Supervising Engineers, Chicago, Ill., with headquarters at 313 Wabash Bldg., Pittsburgh, Penn.

Mr. G. K. Cooper, formerly Junior Engineer, Panama R.R., has been appointed Acting Chief Engineer of the Costa Rica division of the United Fruit Co., with office at Limon, Costa Rica. Mr. Cooper succeeds Mr. F. Brune, who has resigned.

Mr. H. C. Eddy, formerly Secretary of the Electric Railway Commission of the District of Columbia, has been appointed Engineer for the new Public Utilities Commission of the District, which superseded the former commission, as noted in last week's issue of "Engineering News."

Dr. David Franklin Houston, Chancellor of Washington University, St. Louis, Mo., has been appointed Secretary of Agriculture. Dr. Houston was President of the Agricultural and Mechanical College of Texas from 1902 to 1905, and from 1905 to 1908 was President of the University of Texas.

Mr. Everett Morss, M. Am. Inst. E. E., President of the Simplex Electrical Co., and Vice-President of the Simplex Electric Heating Co., of Boston, Mass., has been elected a life member of the corporation of the Massachusetts Institute of Technology. Mr. Morss is a graduate of the Institute, class of 1885.

Mr. C. R. Allen, Jr., Assoc. M. Am. Soc. C. E., for the past seven years with the New York State Highway Department and recently Deputy Division Engineer at Mechanicsville, N. Y., has resigned to enter private practice as Consulting Engineer, with offices at 16 Knickerbocker Bldg., 95 State St., Albany, N. Y.

Mr. H. A. Chandler has been appointed Division Surveyor of the Atlantic division of the Canadian Pacific Ry., at St. John, N. B. The duties of this position include the preparation of plans and descriptions for purchases, sales and leases of land, re-surveys of right-of-way and other survey work connected with the operating and maintenance-of-way departments.

Mr. W. J. Stoneburner, recently with the industrial department of the Missouri, Oklahoma & Gulf Ry., has been appointed General Superintendent of the Alabama, Tennessee & Northern R.R. and the Tombigee Valley R.R., with headquarters at York, Ala. Mr. Stoneburner will have general supervision of the operating, maintenance-of-way and the mechanical departments.

Mr. William C. Redfield, former Vice-President of the American Blower Co., and Member of Congress, New York City, is the new Secretary of Commerce. Mr. Redfield was born in Albany, N. Y., in 1858. For a number of years he was President of J. H. Williams & Co., and of the Sirocco Engineering Co., of New York City. He has been President of the Manufacturers' Export Association for several years.

Mr. Franklin K. Lane, former Chairman of the Interstate Commerce Commission, is the new Secretary of the Interior. Mr. Lane is a lawyer and after practicing in San Francisco, Calif., for a number of years, he was made Corporation Counsel of the city. Mr. Lane was a candidate for Governor of California in 1902. He was appointed a member of the Interstate Commerce Commission in 1905 and was recently elected Chairman.

Mr. J. A. Jordan, Vice-President of the Green Bay & Western R.R., has been elected President, succeeding Mr. S. S. Palmer, deceased. Mr. Jordan entered the railway service in 1869 as an agent of the Chicago & Alton R.R. The other affiliated companies of which Mr. Jordan also becomes President are, the Kewaunee, Green Bay & Western R.R. and the Iola & Northern R.R. Mr. Edgar Palmer, of New York City, succeeds Mr. Jordan as Vice-President.

Mr. Lindley M. Garrison, who has been appointed Secretary of War in President Wilson's cabinet, is a lawyer by profession, and for a number of years was head of the firm of Garrison, McManus & Enright, of Jersey City, N. J. Since 1904 he has been Vice-Chancellor of the State of New Jersey. One of Mr. Garrison's first official acts, according to newspaper reports, was to uphold the decision of his predecessor in the New York harbor pierhead line controversy.

Mr. F. Ringer, recently Engineer of Maintenance-of-way of the Missouri, Kansas & Texas Ry., at Parsons, Kan., has been appointed Division Superintendent with headquarters at McAlester, Okla., succeeding Mr. J. F. Hickey, resigned. Mr. Ringer is a graduate of the School of Engineering, University of Kansas, class of 1893. He entered the service of the Missouri, Kansas & Texas Ry. in 1894 as a levelman on location surveys; a year later he accepted a position as rodman in the maintenance-of-way department, and since then has risen steadily to his recent position of Engineer of Maintenance-of-way.

Mr. William G. McAdoo, the newly appointed Secretary of the Treasury, is known to engineers as the former President of the Hudson & Manhattan R.R., New York City. Mr. McAdoo was born near Marietta, Ga., in 1863. He was admitted to the bar in 1885, and came to New York City in 1892. Mr. McAdoo was the promotor of the Hudson & Manhattan R.R. Co., which carried through to completion the first Hudson River railway tunnels. The scheme for tunneling the river originated in 1874, and the work of excavating the tunnel was carried on intermittently until Mr. McAdoo took hold of the enterprise in 1902.

Mr. Samuel C. Stickney, former Vice-President and General Manager of the Chicago Great Western R.R., and recently in private practice, New York City, has been appointed Assistant to the President of the Erie R.R. Mr. Stickney attended the Massachusetts Institute of Technology, 1883-1886, and began railway work as a rodman on location and construction in Minnesota. He was shortly afterward promoted to be Locating Engineer in Iowa of the Chicago, St. Paul & Kansas City R.R. Later he was appointed Superintendent of Construction and Engineer of Maintenance-of-way of the same railway. In 1890 he was appointed Chief Engineer of the Chicago Union Transfer Ry. From 1892 to 1894 he was Assistant to the President of the Chicago Great Western R.R. and from 1894 to 1909 was Vice-President and General Manager.

Mr. George M. Basford, M. Am. Soc. M. E., has resigned his position as Assistant to the President of the American Locomotive Co., to become Chief Engineer of the railway department of Joseph T. Ryerson & Son, Chicago, Ill. Mr. Basford graduated from the Massachusetts Institute of Technology in 1889, and at once entered the Charlestown, Mass., shops of the Boston & Maine R.R. Later he was a draftsman for the Chicago, Burlington & Quincy R.R., at Aurora, Ill. His next experience was with the motive power department of the Union Pacific R.R., at Omaha, Neb. Following this work he

was Signal Engineer of the Chicago, Milwaukee & St. Paul Ry. and Superintendent of Construction of the Johnson Railway Signal Co. Later he was connected with the Union Switch & Signal Co. and Signal Engineer of the Hall Signal Co. From 1895 to 1897 Mr. Basford was Editor of the "Railway & Engineering Review," and from 1897 to 1905 Editor of the "American Engineer and Railroad Journal." Mr. Basford's headquarters will remain in New York City, where his offices will be at 30 Church St.

OBITUARY

John W. Crissey, Assistant Engineer of Construction of the Lake Shore & Michigan Southern Ry., at Cleveland, Ohio, died, Mar. 7, at Chicago, Ill., from pneumonia. Until recently he was Resident Engineer at Chicago.

Seth Lee Keeny, a railway contractor, who built portions of the Delaware, Lackawanna & Western R.R. through the Delaware Water Gap, died at his home in Brooklyn, N. Y., on Mar. 13. Mr. Keeny was also contractor for the Prospect Park reservoir in Brooklyn.

Alexander H. Sherrerd, M. Am. Inst. M. E., died at his home in Newark, N. J., on Mar. 14, from acute indigestion. He was 53 years old. For many years he was connected with the Lackawanna Iron & Coal Co., and more recently had been in private practice as a mining and metallurgical engineer in Scranton, Penn. He is survived by a widow and one son.

Dr. Frederick Schniewind, a chemist known chiefly for his many discoveries in the use of byproducts of coke ovens, died at his home in Englewood, N. J., on Mar. 13. He was 52 years old and was born in Germany and educated at the University of Heidelberg. He was a member of the American Gas Institute and of the Iron and Steel Institute of Great Britain.

Arthur W. Moss, Superintendent of the Schuylkill division of the Pennsylvania R.R., died Mar. 12, at Reading, Penn. He was born in Philadelphia, Penn., May 4, 1859. He received his education at Phillips Scientific School and entered the service of the Pennsylvania R.R. in 1877 as a shop apprentice. He was promoted successively to be draftsman, assistant in the test department, assistant road foreman of engines, assistant freight trainmaster, passenger trainmaster and division superintendent.

Peter Brady, a prominent citizen of Easton, Penn., and a former pioneer Western railway engineer, died at his home in Easton on Feb. 27. He was born in Ireland in 1823 and attended the famous engineering school at Castle Pollard, County West Meath, where he was graduated in 1845. The following two years he served as an assistant engineer on public works for the British Government. He emigrated to America in 1848 and for several years was engaged in survey and engineering work in the Pennsylvania coal mining region. He then went West and for a time was engaged in surveys for the Marietta & Cincinnati R.R., in Ohio. He continued in railway location and construction in the Middle West until 1859, when he returned to the East and settled in Easton, Penn. After several years in various kinds of engineering work he was appointed Chief Engineer of the Wilmington & Reading R.R. He then turned to mining engineering and for more than 30 years was associated with Glendon Iron Co.

Dr. John Shaw Billings, former Director of the New York Public Library, at one time a prominent army medical officer and famous as a sanitarian, died at his home in New York City, Mar. 10. He was born in Switzerland County, Ind., Apr. 12, 1839, and was graduated from Miami University in 1857. He received the degree of Doctor of Medicine at the Medical College of Ohio in 1860. Here Dr. Billings served as an instructor until the outbreak of the Civil War, when he entered the army as an assistant surgeon. He remained in the Medical Corps of the army until 1895, when he retired with the rank of Lieutenant-Colonel, after having served as Deputy Surgeon General. Dr. Billings was in charge of the library of the Surgeon General's office for a number of years and made an index in 16 volumes of this library. He was in charge of the compilation of vital statistics of the 10th census and of the social and vital statistics of the 11th census. He was Professor of hygiene at the University of Pennsylvania in 1891. From 1893 to 1896 he was Director of the New York Public Library. Dr. Billings was a member of many learned societies in this country and abroad. He received honorary degrees from the Universities of Edinburgh, Harvard, Buda-Pesth, Yale, Johns Hopkins, Munich, Dublin and Oxford. He was the author of numerous works on medicine, hygiene, sanitation and allied subjects.

Sir William Arrol, the famous English bridge builder whose death was noted in our issue of Feb. 27, was a type of those eminent engineers, whose lives furnish inspiring examples fo the generations who follow them. An interesting sketch of his long and useful career appears in London "Engineering" of Feb. 21, from which we take the following abstract:

Sir William Arrol won honor and fame by following the simple plan of acting well his part. There fell to his lot some of the greatest problems in constructional engineering and in the organization of men and affairs; but he always met them with the firm assurance that a solution could be found by hard work and unfailing perseverance, and no seeming failure ever caused him to despair or to resort to subterfuge. Time and again he undertook works in which there was no precedent to guide him, and which were so far in advance of experience as to constitute a new departure in engineering science. And yet his preparation for his life's tasks was the antithesis of that involved in the modern conception of an engineer's training.

No one despises the higher accomplishments of scientific knowledge, least of all did the late Sir William Arrol; they are essential to development in engineering. But the achievements of his life tend to demonstrate that other things are needful, and chief among them is character. The secrets of Sir William's success were his ingenuity in mechanics, his sound common-sense, his tenacity of purpose, and his uprightness, especially in his relationship with workmen.

Sir William was born in the village of Houston in 1839. He was fortunate in having ideal schoolmasters, with the result that there was laid a solid foundation upon which to build up the experience and to assimilate the lessons of everyday life. At an early age he entered Coats' mill, being engaged in the turning-shop or spool department. At the age of 14 he was apprenticed to Thomas Reid, blacksmith, in Paisley. By working in various towns in England and Scotland he widened his experience and accumulated knowledge. Even as a blacksmith he displayed the inventor's faculty which ultimately made him one of the greatest engineering constructors of our time.

In 1863, when only 24 years of age, he became foreman in Laidlaw's boiler works in the Bridgeton district of Glasgow. There he continued for five years, after which he started business on his own account. His capital, the savings of his life up to that time, amounted to about $425. The engine for driving his shop was purchased for $90, and the boiler for $125. From this small beginning there has arisen the largest structural steel works in the United Kingdom, ocupying about 20 acres and employing at times something like 5000 men.

The first important work undertaken, and the first to bring Sir William prominently before engineers, was the erection, in 1875, of a viaduct over the River Clyde at Bothwell, for the Caledonian Ry. The practice had hitherto been to erect such bridges in position upon extensive scaffolding, but Sir William set up the longitudinal girders on the land, and, by means of rollers, actuated by ratchet-bars, projected them as a continuous girder across the river from pier to pier, until the completed length of 727 ft. was in position. The superstructure was afterward completed on the main longitudinals.

The next important contract was the building of the very heavy viaduct across the Clyde at Glasgow, for the Caledonian Ry. On this bridge he first applied his hydraulic riveter. After devising the machine itself, he found great difficulty in getting flexible supply-pipe to withstand the hydraulic pressure of 1000 lb. per sq.in. But it was characteristic of his method of procedure that he went to the rubber works and remained there continuously until, by a cut and try process, he had himself devised a satisfactory pipe.

The most famous works accomplished by Sir William were the reconstruction of the viaduct over the Firth of Tay and the building of the great cantilever bridge over the Firth of Forth. This bridge was for long, and is still, one of the wonders of the world. While universal recognition was paid to the designers for the conception and design, equal credit was conceded to Sir William Arrol, without whose services in devising mechanical methods of executing the work, the bridge could not have been built in the time and for the cost—namely, $15,000,000. It is only possible here to indicate some of the directions in which Sir William's ingenuity displayed itself. There were details in connection with the machinery for sinking the caissons for the piers under air pressure. When the hard boulder clay was reached, for instance, it was found so dense and tenacious that until Sir William Arrol devised an hydraulic spade the work of excavation could not be proceeded with. The